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Merry Christmas

TO ALL to whom these presents may come, the publishers and editorial staff of Power extend their hearty wishes for an abundant measure of the happiness and good cheer that goes with the Christmastide.

The grind and burden of the year, the effort for a record of service and improvement and betterment have been punctuated with bright spots of either general or personal celebration.

National holidays with their noise and oratory, the vacation with its change of scene and intimate enjoyments, have broken the monotony but they have been largely for you and yours.

There is something about Christmas that is more inclusive. Whole nations of men and women turn for a season from their self-concentration and, in a spirit of good will and well wishing, join in and add to the general good fellowship.

For weeks they have been planning and choosing gatherings and remembrances that will make others happy. And in the realization of that happiness, in which all are donors and recipients, lies the charm of the season.

And those who have tried it, tell me that they have found their greatest satisfaction in carrying with them this spirit of disseminating happiness, not in perpetual gifts but in little words and acts that mean pleasure and satisfaction instead of slight and resentment to those to whom they are addressed.

May the spirit of Christmas, peace on earth and good will toward men, be and abide with us through the year that is to come.

F. R. Low

An Up-to-Date High Back-Pressure Power and Heating Plant

Ample Room and Daylight, Even in the Basement, Show the Value of Attention to Operating Convenience on the Part of the Plant Designer. Provision for Burning Factory Wastes Reduces Handling Costs

BY G. B. PATTISON
Maintenance Engineer, Frederick Stearns & Company, Detroit, Mich.

IN the manufacture of a varied line of drugs and perfumes in the Detroit plant of Frederick Stearns & Co., it is necessary to furnish large quantities of steam for cooking and other process work, as well as considerable electric energy for driving machinery. To meet the growing demand for heat and power with acceptable economy, a new power plant has recently been completed, equipped with turbine-driven electric generators receiving steam at 250 lb. per sq.in. gage and exhausting at 40 lb. gage to the factory service lines.

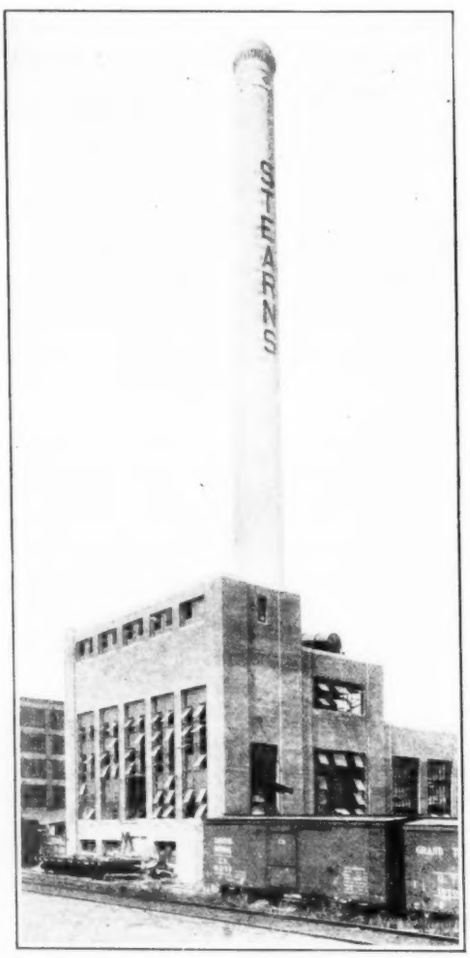
It was decided to generate steam in the boilers at 250 lb. in order to obtain as small a water rate as possible, without getting into the higher pressure or superheat which requires the more expensive valves and fittings. Steam turbines were selected to avoid oil in the exhaust steam for process work. The character of the load showed that some exhaust steam would be wasted in the summer time, but that the installation of condensers and bleeder turbines would not be warranted.

The general scheme of operation combines live and exhaust steam heating. Steam is generated at 250 lb. to supply turbines, boiler-feed pumps and auxiliary drives. It is also reduced by pressure-regulating valves to 125 lb. to supply a small amount of process steam in adjacent buildings. It is again reduced to 40 lb. pressure to supply the demands of process work, beyond the supply of exhaust steam from the main generating unit turbines. A pressure regulating valve in the 40-lb. line supplies any deficiency in the auxiliary exhaust system which operates at from 2 to 10 lb. pressure; also, regulating valves are installed throughout the plant to supply 2-lb. steam for heating in the winter.

It is the intention to operate the process steam lines at from 40 to 50 lb. in winter and as low as 20 lb. in summer in order to conserve coal. Similarly, the auxiliary exhaust will be operated at 10 lb. in the winter and approximately 1 lb. in the summer.

There are three boilers, each with 4,000 sq.ft. of heating surface, fired by multiple-retort underfeed stokers, five retorts under each boiler.

A good grade of bituminous coal is delivered to the stoker hoppers by a weigh larry from a parabolic bunker which is filled by a bucket elevator. Provision is also made for burning factory wastes, consisting of drug dregs, sawdust from the wood box factory, etc. This material is fed to a hopper at one end of the bunker and carried by a flight conveyor to spouts which discharge above the stokers, so as to facilitate the handling and burning of this wet fuel.

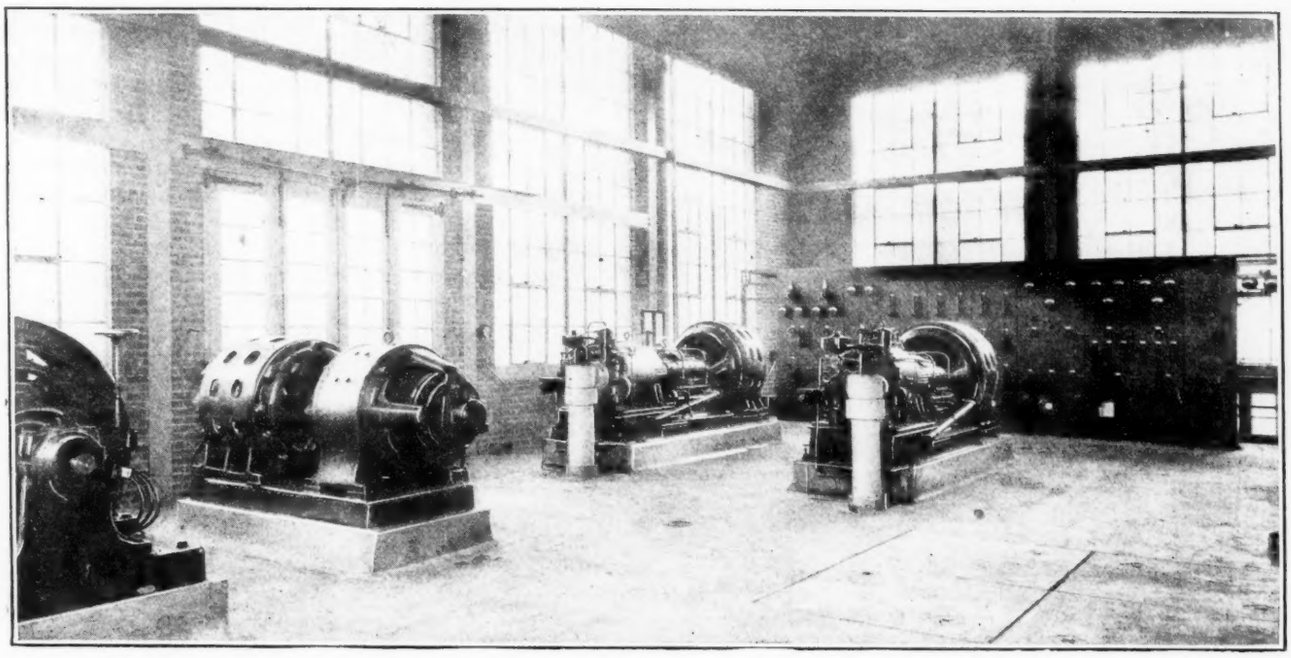


Exterior View of Plant

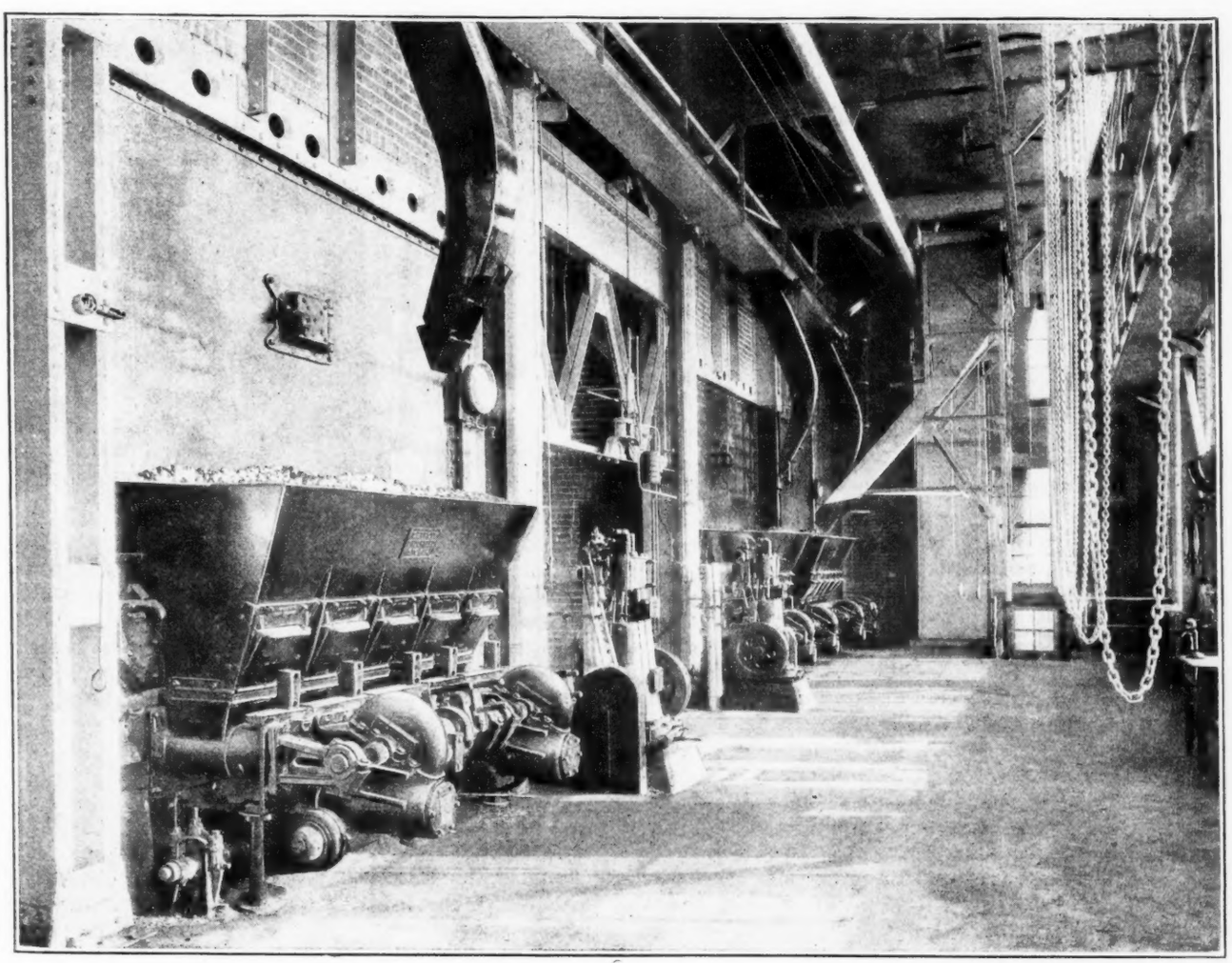
Combustion air is supplied by either of two forced-draft fans, one motor-driven, one turbine-driven. These discharge to a common duct, with a damper in the branch to each boiler. The speed of both fans and of the stoker engine is under the control of a steam pressure responsive regulator. The damper to the windbox of each stoker is manually controlled, as is the damper through which the gas passes from each boiler to the stack breeching.

Natural draft is provided by a reinforced-concrete stack 215 ft. high above grade, 175 ft. above its support on the plant roof. It is 9 ft. inside diameter lined for 50 ft. from the bottom.

Air enters the furnace not only through the stoker tuyeres, but also through perforated blocks in the front wall, immediately above the stoker ram boxes. These are provided principally to promote the burning of the dregs and wood waste dumped on top of the coal fire. Draft gages, steam-flow-air-flow meters and flue-gas thermometers enable the operator to control combustion conditions easily.



The turbine room houses the main switchboard and two motor-generator sets for furnishing direct current



The boiler room is characterized by ample space and excellent lighting

The stokers are driven by small reciprocating steam engines that exhaust to the feed-water heater and to the heating system of one near-by building at a pressure ranging from atmospheric to 8 or 9 lb. gage.

Ashes are discharged from gated hoppers into steel-body trucks, which are dumped to the same bucket elevator used for coal handling. This delivers the ashes to a compartment at one end of the coal bunker, whence they are spouted to trucks or railroad cars. In Detroit there is a ready market for ashes for use as fill, etc.

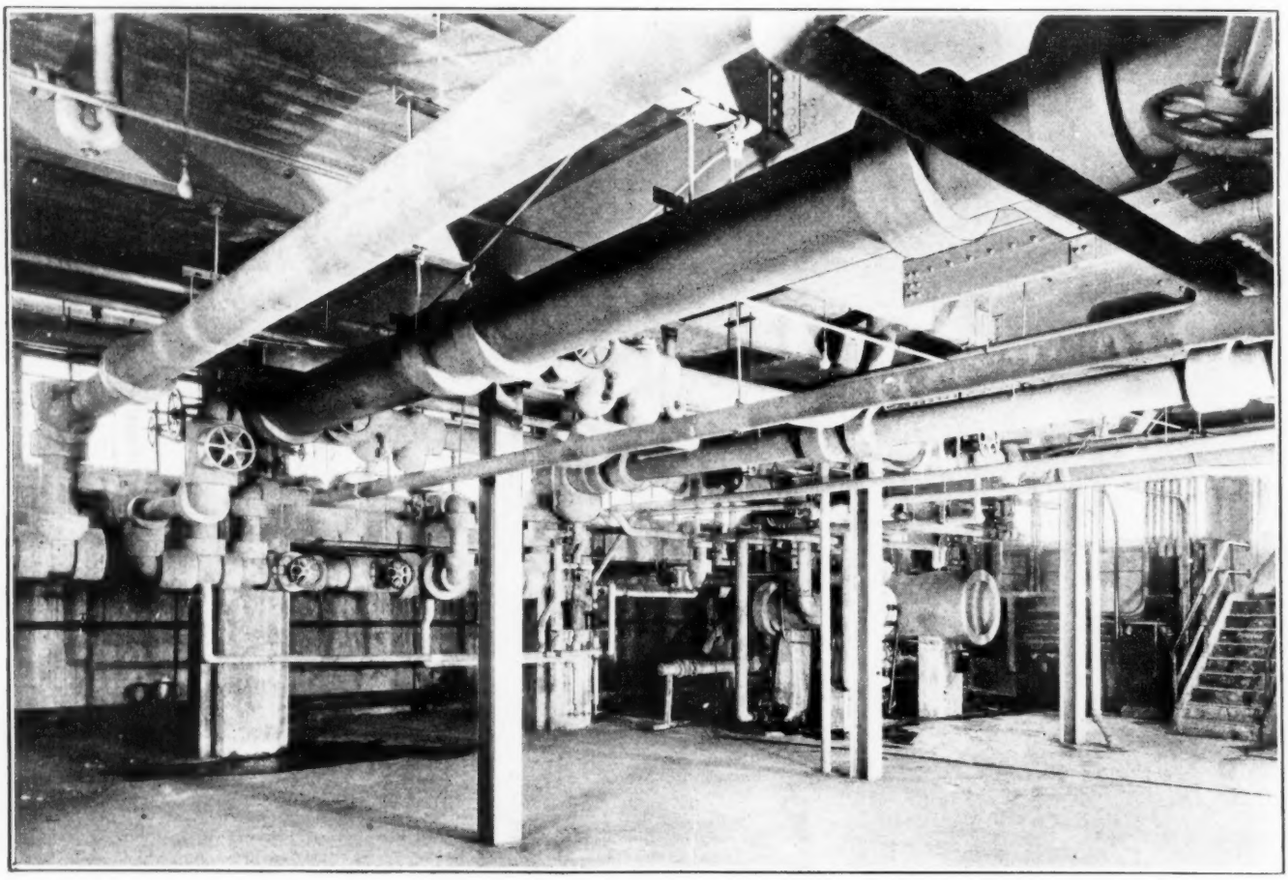
Boiler feed water consists largely of returns from the steam-heated process equipment, together with the distilled water from evaporator condensers. Accordingly, little makeup is required, and this is Detroit city water that has been used as circulating water in process condensers. This is fairly free from scale-forming materials, so that there is no apparent need for water treatment. The boilers show no serious scaling, and they have operated at loads as high as 300 per cent of their nominal rating.

The returns are collected in a tank in the basement, whence they are delivered to the boiler feed heater above the feed pumps. An interesting detail is the transfer pump, a 2-in. centrifugal pump running at 1,750 r.p.m. and successfully handling water at 212 deg. F. with only 3-ft. suction head. A 4-in. suction pipe is carried to a reducing elbow at the 2½-in. pump suction, and the outfit works altogether satisfactorily.

This pump delivers the hot water to a vented air separating tank above the feed-water heater. In this tank is a float valve for supplying city water when the level falls unduly. A globe valve in the vent with an automatic valve in a bypass gives ample capacity for unusual conditions with minimum loss of vapor during normal operation.

Water passes from the heater to the 2-in. 7-stage centrifugal feed pump running at 3,500 r.p.m., or to the stand-by duplex pump. Both pumps are automatically governed for constant excess pressure, and the flow to each boiler is regulated by a level-control regulator.

Piping and valves are so arranged that upon failure of the city water supply water may be drawn from the hot and cold domestic water systems, and in an extreme case from the 50,000-gal. sprinkler tank. The factory water system alone contains enough water to run two boilers at rating for several hours.



The basement has adequate natural light, and the piping layout makes everything easy to follow and get at

Each boiler is equipped with a steam purifier designed to remove moisture and solids from the steam. From the purifier steam is delivered to a header system below the boiler-room floor, from which it passes to the turbine room or, through reducing valves, to the 40-lb. process steam system.

Three turbine-driven geared generating sets furnish alternating current at 440 volts. Each of these units is rated at 350 kva. and the turbine runs at 4,000 r.p.m., the generator at 1,200. Two motor-generator sets furnish direct current at 240 volts to such machines as require it.

The turbines exhaust at 40 lb. gage and have a steam rate of 53 lb. per kw.-hr., which corresponds to an

engine efficiency of about 54 per cent. They are mounted on heavy concrete pads built into the floor and operate without appreciable vibration or noise.

A dead-front switchboard at one end of the turbine room controls the distribution of energy, and the usual instruments guide the operator.

Selecting the Exhaust Pressure

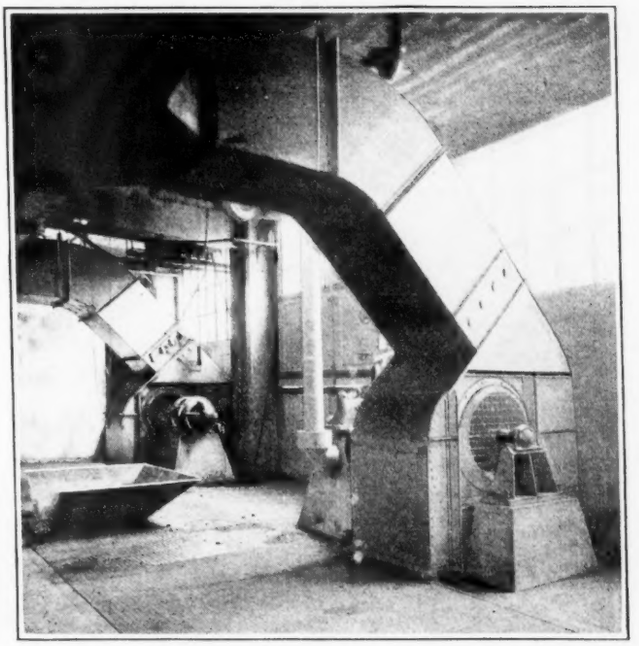
Prior to the design of this plant the factory process work was studied with a view to lowering the steam pressure required, which ran as high as 90 lb. on much equipment. By suitably increasing the heating surface in several instances, it has proved entirely feasible to operate on 40-lb. steam, and it is believed that this can be done throughout the works. This obviously increases the electric energy that can be developed from each pound of steam and increases the efficiency of the plant.

The heating system operates at pressures below 10 lb. gage and is fed through reducing valves from the 40-lb. exhaust steam system.

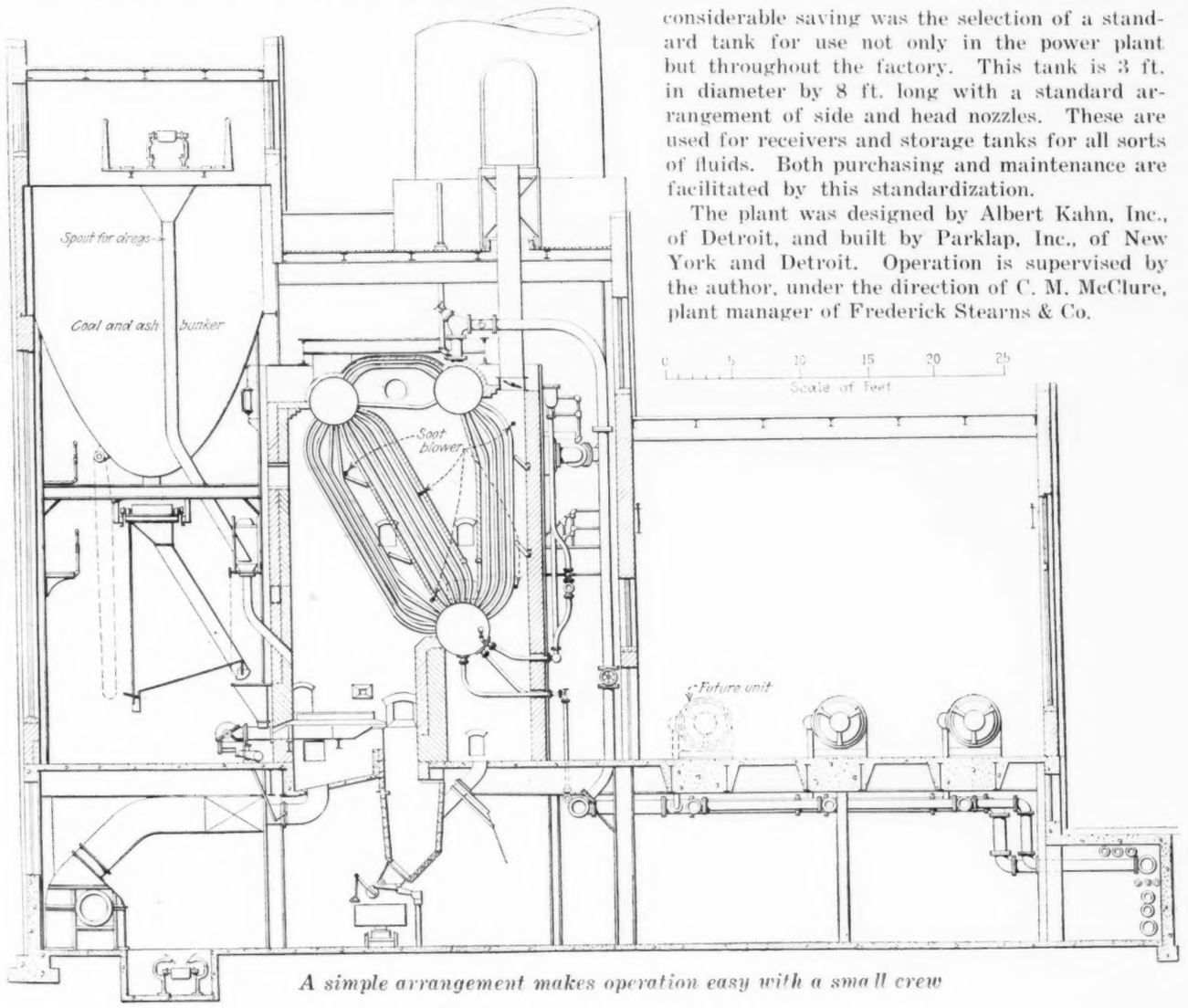
A noticeable and pleasing feature of the plant is the ample space that has been provided and the splendid natural light through ample windows. Even the basement has adequate daylight. The piping is all overhead and is arranged with care to facilitate maintenance and operation.

One seemingly minor detail that has resulted in a considerable saving was the selection of a standard tank for use not only in the power plant but throughout the factory. This tank is 3 ft. in diameter by 8 ft. long with a standard arrangement of side and head nozzles. These are used for receivers and storage tanks for all sorts of fluids. Both purchasing and maintenance are facilitated by this standardization.

The plant was designed by Albert Kahn, Inc., of Detroit, and built by Parklap, Inc., of New York and Detroit. Operation is supervised by the author, under the direction of C. M. McClure, plant manager of Frederick Stearns & Co.



One forced-draft fan is driven by a motor, the other by a steam turbine



A simple arrangement makes operation easy with a small crew

How Should Squirrel-Cage Motors Be Started?

By G. O. WILMS
Chief Engineer, Allen-Bradley Company, Milwaukee, Wisconsin

The Reader Is Given a Look Inside the Two General Types of Reduced-Voltage Starters and Shown What Happens During the Period When the Motor Is Being Started

IT IS a well recognized fact that line disturbances when starting induction motors are caused not so much by the amount of current drawn from the line as by the suddenness with which the current is taken. Therefore, to improve objectionable line condition caused by starting squirrel-cage motors, a time element should be specified to regulate the starting of such motors. Any change in the power demand will produce a voltage change, since it takes time for the system to become adjusted to the new condition. Therefore, any change in the power demand will set up a greater disturbance if the demand is made suddenly than if the current increases slowly. There are two general types of starter for squirrel-cage induction motors—primary resistance and auto-transformers.

Single-Step Primary-Resistance Starters

The simplest form of primary-resistance starter is the single-step type, which has the advantage over the compensator type starter in that the voltage across the motor terminals increases as the machine comes up to speed. This action comes into effect after the motor has accelerated to about 50 per cent speed. These starters are provided with taps similar to the taps on the compensator; or in the case of the graphite compression-type resistor, they are provided with an adjustment screw that permits an adjustment for any starting current desired. This type of resistor has the added advantage that the negative temperature coefficient of the graphite will automatically reduce the resistance during starting, thus providing a cushioned start.

The oscillogram, Fig. 4, shows the starting of a standard squirrel-cage motor with 300 per cent normal current by means of a single-step graphite compression resistor. This oscillogram shows how the voltage increases across the motor terminals, so that at the point of switching to full voltage only a very small current rush takes place. For example, in the figure the switch is closed at *A*. The current taken by the motor is represented by the top curve and the voltage across the motor terminals by the bottom curve. The current

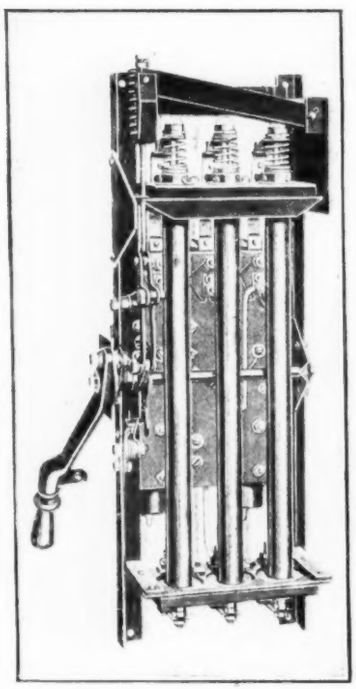


Fig. 1—Rear view of starter, Fig. 2

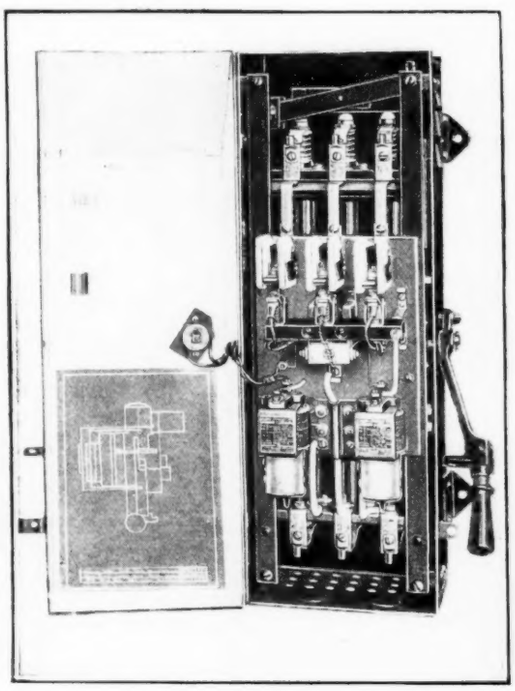


Fig. 2—Manual compression-type graphite-disk starter

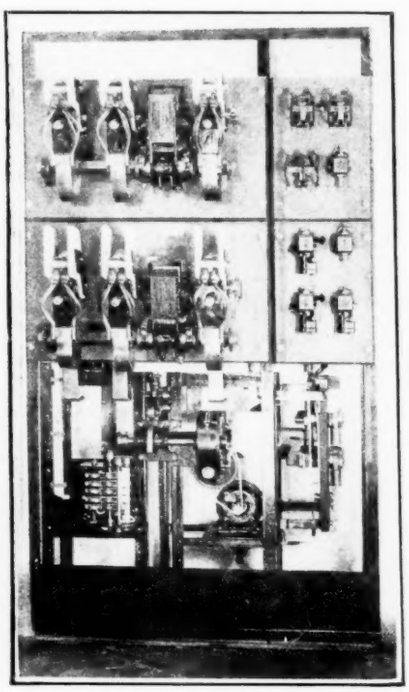
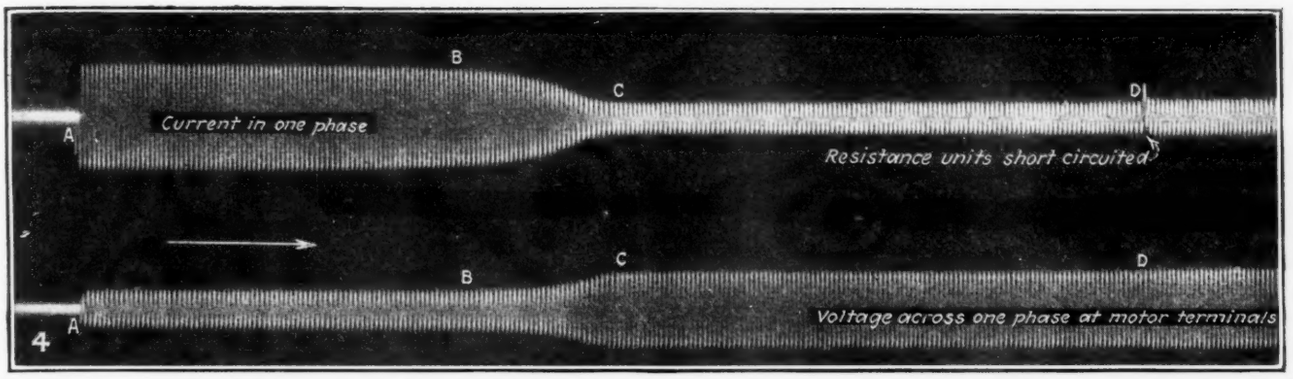
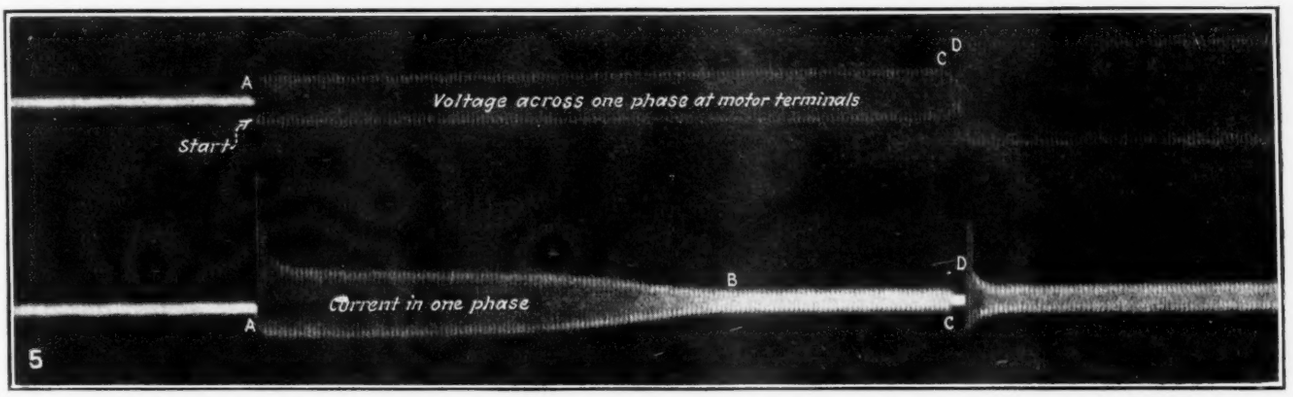
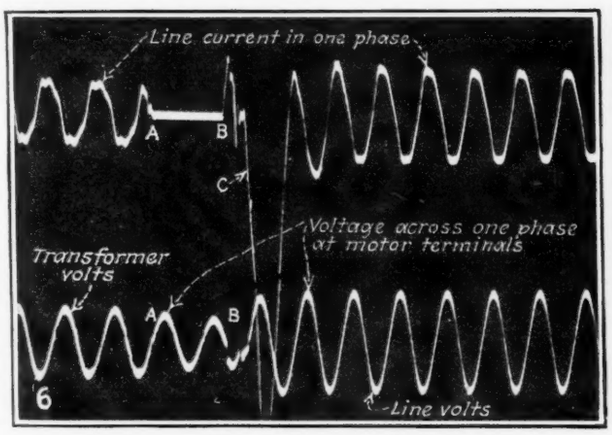
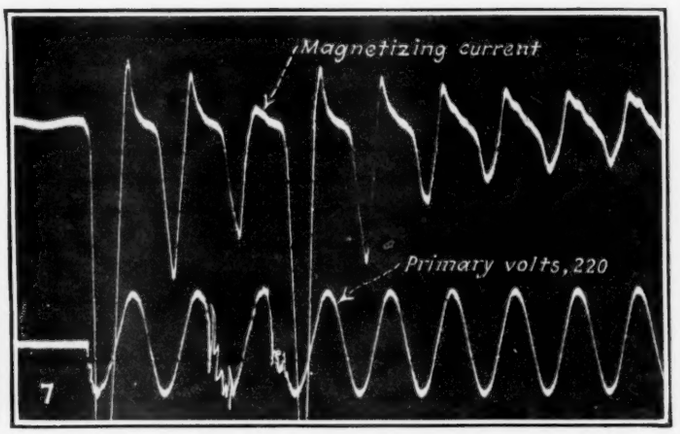


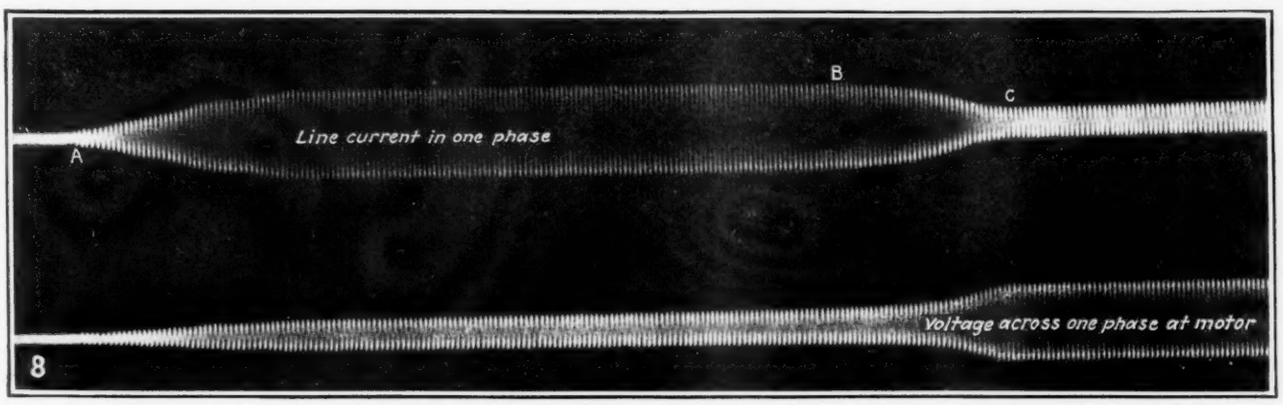
Fig. 3—Automatic graphite-disk starter











Figs. 4 to 8—Oscillograms showing the starting current taken by squirrel-cage motors when started with different types of starting equipment

Fig. 4—Starting current and voltage with single-step resistance starter. At *A* the motor is connected to the line through the resistance and remains connected until point *D* is reached, when the resistance is short-circuited. Fig. 5—Starting current and voltage when squirrel-cage motor is started with auto-transformer. Fig. 6—Curve *C*, current inrush when motor is changed from low to full voltage with an auto-transformer. Fig. 7—Magnetizing current taken by auto-transformer. Fig. 8—Changes in starting current and voltage when squirrel-cage motor is started with compression-type graphite-disk resistance starter.

and voltage remain about constant for the period from *A* to *B*, or about one second, when the current starts to decrease and the voltage to increase. At *C* the voltage and current have again reached a stable condition, the motor having been accelerated to nearly full speed. The current and voltage remain constant until at point *D*, then the contactor closes and short-circuits the resistor unit, when for about one-half

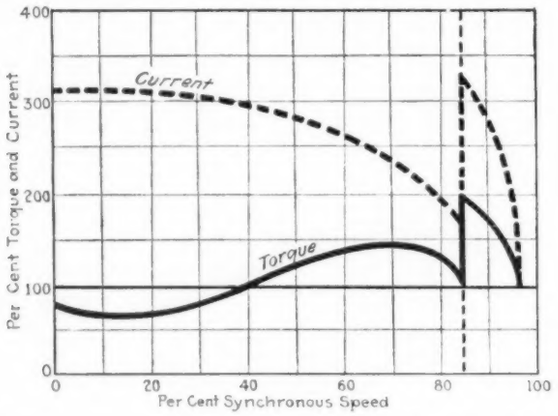


Fig. 9—Current and torque curves of squirrel-cage motor when started with auto transformer

cycle there is a slight increase in the current. It will be noted that the voltage at the motor terminals had practically reached normal value before the resistance was cut out of circuit. This accounts for the very small rise in the current when the motor is connected to full voltage. In this case the time of bringing the motor up to full speed and switching to full voltage was accomplished in a period of about four seconds, the oscillogram representing a 60-cycle circuit.

Auto-Starter or Compensator

Fig. 9 shows the approximate current and torque curve of a squirrel-cage motor started with a compensator that limits the current to about 300 per cent of normal full-load value. The starting torque in this case is about equal to 65 per cent of normal. When the current has fallen to about 150 per cent of normal, the motor is connected to full line voltage and the second inrush is shown to be about the same as the first. This, however, is an uncertain value and, not only can it exceed the first current inrush, but it may be several times the locked rotor current.

With the compensator the motor is accelerated under reduced voltage, is then disconnected momentarily from the low-voltage taps and switched to line voltage. During switching over from reduced to full voltage, the stator current is zero, but the stator flux or magnetism does not disappear instantly. While the stator flux is diminishing, the rotor is revolving and slowing down. Since the flux has not entirely disappeared, current is still induced in the rotor, which produces a revolving field running at rotor speed, that generates a voltage in the stator windings. Therefore, the frequency and voltage induced in the stator are lower than the line frequency and voltage, so that the phase relation between induced stator voltage and line voltage is constantly changing. When the compensator switching mechanism reconnects the motor to the line, the induced voltage in the stator may be in phase with the line voltage. This is the worst condition, and in such an event the momentary current which will flow almost approaches a short-circuit. Only by the merest chance are the stator and the line voltages likely to be in phase opposition, in which case the inrush current will be a minimum value. While the period of switching over is small, it is sufficient to allow a serious phase displacement between induced stator voltage and the line voltage, and therefore a second heavy current inrush is common. Furthermore, this second current inrush is beyond the control of the operator, and even with automatic switching arrangement it cannot be controlled.

The conditions referred to in the foregoing are shown in Fig. 5. At *A* the motor is connected to low voltage and there is an inrush of current to the motor, which gradually decreases until point *B* is reached and remains practically constant until at point *C*, when the motor is disconnected. The motor remains disconnected until at point *D* it is connected to full voltage and there is another sharp rise in the current. On the voltage curve from *C* to *D* it can be seen that the voltage across the motor terminals did not decrease to zero as did the current, but gradually decreased. The voltage indicated from *C* to *D* is that induced in the stator by the revolving field set up by the rotor's current.

If the motor is connected to full line voltage at an instant when the stator voltage is in phase with it, the second inrush may be very high. A case of this kind is shown in Fig. 6, taken with a high-speed film in the oscillograph. At *A* the motor is disconnected from

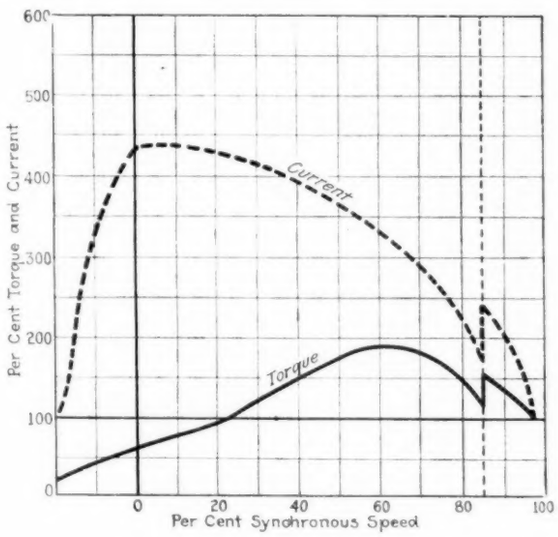


Fig. 10—Current and torque curves of squirrel-cage motor when started with resistance-type starter

reduced voltage by opening the compensator switch, and is connected to full line voltage at *B*, when a current inrush occurs, as indicated by the wave *C*. This inrush is about eight times the value of the current taken by the motor after normal operation has been established. From *A* to *B* the voltage across the motor terminals did not come to zero as did the current in the stator windings, but had decreased only a small amount when the motor was connected to the line again.

At *A* on the current curve, Fig. 5, it will be noted that the initial current inrush is high. In any apparatus that has either inductance or capacity, or both, the current initial inrush will be much higher than the

ultimate value, the current peak depending upon what part of the voltage curve the switch is closed. The reason for the high initial peak current is that at the instant of closing the switch the current is limited only by the ohmic resistance of the circuit. This fact is not always recognized in connection with compensator starting and in a way defeats the action of the compensator; that is, to reduce the line current by transformer action.

It is a well-known fact that large currents are taken at the instant of closing a switch on a transformer. Fig. 7 shows an oscillogram obtained when magnetizing a 10-hp. compensator with the secondary disconnected. The current inrush analyzed to about 80 amperes, whereas the normal magnetizing current measured 5 amperes. The distorted wave shape is due to the unloaded condition of transformer and will be less noticeable if the motor is connected to the secondary.

The Graphite Compression-Type Starter

Considering the resistance starter under the same condition as assumed for the compensator in Fig. 9, the current and torque curves show that theoretically 430 per cent current is required from the line for 65 per cent torque, as shown in Fig. 10. This looks bad for the resistance starter, but the conditions are not so bad as they appear. The current necessary to start the motor does not flow suddenly, as in the case of the compensator, but rises gradually from less than normal to the required value for starting. When the motor starts, the current begins to drop, and at about 85 per cent speed the motor is connected to the line by short-circuiting the resistance, which is done without opening the main-line circuit. Since the voltage drop across the resistance has gradually diminished, owing to the decreased starting current, the second current inrush is comparatively small, and under the control of the operator, or in case of automatic equipment, can be governed by a relay.

The starting condition obtained with a compression-type primary-resistance starter is shown in the oscillogram, Fig. 8, which is that of a manually operated starter. The gradual building up of the current from point *A*, when the motor is connected to the line, and the gradual decreasing of the current from *B* until the motor is connected to full voltage at *C* can be seen. No current inrush can be observed when the motor is finally connected to full line voltage.

The resistance-type starter, such as the semi-automatic shown in Figs. 1 and 2, has three compression rheostats, one in each phase, providing balanced condition. By slowly lifting the handle, pressure is gradually applied to the graphite disk columns in the three vertical tubes, Fig. 1, and as the pressure increases the resistance decreases. Finally, a point is reached when sufficient starting current flows to start the motor. The motor will now accelerate and the final motion of the handle will energize the magnetic running switch, which will close, connecting the motor to full line voltage without disconnecting it from the reduced voltage. Whatever second current inrush should take place is always of low value and under control. No uncertainty exists as in the case of the compensator, where the second inrush depends on the phase relation of line and generated stator voltage, and which is beyond the control of the operator. Manually operated starters of the compression type can be built up to 400 hp. capacity.

Where gradual starting is desired automatically, starters of the type shown in Fig. 3 are used. A small pilot motor, controlled by suitable relays, accomplishes the starting cycle and a starting characteristic, similar to that shown in the oscillogram, Fig. 8, is the result.

Primary-resistance starting differs distinctly from the compensator method. In the first method the voltage at the motor terminal varies with the current, whereas with the latter a constant voltage is impressed on the motor. When squirrel-cage motors of larger sizes were first used, it was necessary to apply a lower voltage during starting in order to reduce as much as possible the current taken from the line. If this was not done, it was found at times impossible to start the motors from the limited power supply. With large-capacity power stations, the load due to starting of larger-size squirrel-cage motors, as far as the generating station is concerned, is not great. Disturbances on feeder lines, however, due to sudden drawing of large currents, is still a serious matter. Every power system has a time constant in which the power demand can be changed with a minimum of disturbance. The gradual-type primary-resistance starter offers the possibility of drawing current from the line with least disturbance.

Prevention of Corrosion

Plant treatments with sodium phosphate have not been sufficiently extensive to determine exactly the amount of corrosion protection possible from this retarder. Three tanks have been treated, and the initial protection in all three has been excellent for galvanized metal as well as for iron and steel. The rust on the ice cans and the coils was gradually removed by the phosphate and at the end of a month the phosphate appeared to have been used up, possibly in the formation of a protective film.

In freezing tank 4 at the Howard Street plant of the Boston Ice Co., 200 lb. of disodium phosphate was dissolved in hot water and added to the brine. This tank contains an estimated volume of 1,875 cu.ft. of sodium brine, so this addition was equivalent to an addition of 1.66 grams per liter. A ten-day test on bare metal made after this addition showed that a 98 per cent reduction in the corrosion rate of iron and steel had been accomplished. The rust began coming off the cans and the coils, and a month later it was found that the corrosion rate had returned to its original value. This indicated that the phosphate had been used up. This second corrosion rate, however, should not be taken as a measure of the protection afforded the metal by the original application of phosphate. In freezing tank 3, at the Howard Street plant, 100 lb. of disodium phosphate were added to the brine without previous dissolution. This salt apparently did not dissolve, so a second addition of disodium phosphate was made in this case, with previous dissolution in hot water. After this addition, tests on galvanized metal showed that a 79 per cent reduction in the corrosion rate resulted. The corrosion rate of bare metal was reduced 60 per cent. In this tank the rust also began coming off of the cans and the coils, with the result that the corrosion rate mounted to its original value.—*Report of Corrosion Committee, A.S.R.E.*

Third Unit for Waukegan 50,000 Kilowatts

FOR the Waukegan Station of the Public Service Company of Northern Illinois a third unit is under construction, to be ready for service during the spring of 1927. The addition of a 50,000-kw. machine to the 25,000- and 35,000-kw. units previously installed will bring up the station capacity to 110,000 kilowatts.

The new unit is to have a single 1,800-r.p.m. generator with directly connected exciter driven by a tandem-compound turbine with a single-flow high-pressure cylinder made of steel and a cast-iron low-pressure cylinder arranged for double flow. The blading is of the reaction type throughout and of nickel chrome steel or monel metal.

In general the construction follows closely previous Allis-Chalmers design, including end tightened blading with axial adjustment of clearance. To avoid joints or fits in the high-pressure region, the high-pressure shaft is made in two pieces, the body and high-pressure end being one forging into which the exhaust end of the shaft is forced and secured by stud bolts. A shaft, onto which rings are shrunk to carry the blading, forms the low-pressure spindle. A feature is the central longitudinal boring of both shafts to permit periscopic inspection.

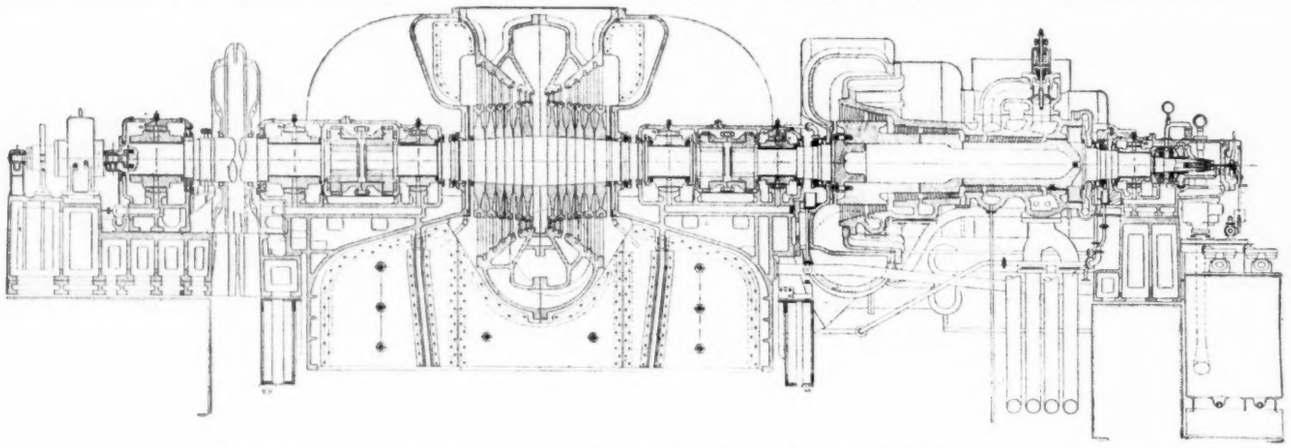


Fig. 1—Longitudinal section through 50,000-kw. turbine (generator not shown)

Two spherical seated bearings support each turbine shaft and the generator rotor, the three shafts being connected by flexible couplings. Kingsbury thrust bearings take up the unbalanced axial thrust on the turbine shafts, and for the generator, babbitted end surfaces on the inner supporting bearing oppose shoulders on the rotor shaft.

Operating steam conditions are to be normally 600 lb. gage, 725 deg. F. and a vacuum of 29 in. at the exhaust nozzle. Five nozzles have been provided for steam extraction, three being in the high-pressure cylinder, one in the low-pressure cylinder and one in the interconnecting piping between cylinders.

The 50,000-kw. generator at 85 per cent power factor is the largest 1,800-r.p.m. machine so far undertaken by the company. Three-phase 60-cycle currents will be generated at 12,000 volts.

To maintain rotor stresses within conservative limits and avoid large air friction losses from excessive peripheral speed, the rotor is of moderate diameter and naturally long. To give the rated capacity, the length of the stator core between end heads is approximately 18 ft. The weight of stator complete is 265,000 pounds.

Adequate cooling of the central portion of so long a stator introduced an interesting problem in ventilation. Approximately 140,000 cu.ft. of air per minute will be delivered by two external motor-driven fans into the inclosures at each end of the stator. Passing along 14 tapered inlets back of the stator laminations, the air will flow radially inward to the air gap, then through the air gap circumferentially for a short distance and radially outward through the yoke. In each half of the machine there are fourteen air inlets and fourteen outlets, each inlet supplying air to three coils on the inlet side and three on the discharge side. A portion of the air will be bypassed back of the coils to carry off heat generated in the base of the stator core.

The rotor, weighing 145,000 lb., was made from a single forging properly turned and slotted for the wiring. The shaft ends are integral with the rotor body. Although air ducts are provided in the rotor, dependence is placed mainly on surface cooling. Cool air from the radial ventilating system previously mentioned is blown against the rotor surface for its full length.

A two-pass surface condenser of the oval shell type with shallow tube bank will serve the unit. Surface aggregating 57,000 sq.ft. will be supplied with 70,000 gal. of cooling water per minute. A large central steam lane with adjustable baffle plates, makes it possible to regulate the steam flow direct to the hotwell so as to maintain the desired temperature throughout the year without sacrifice of vacuum. Tubes will be expanded into the tube sheet at the front water-box end and packed into the tube sheet at the return end.

Two circulating pumps of the vertical-shaft type will supply the cooling water. Each pump will deliver 35,000 gal. per min. at 19 ft. total head and will be driven by a two-speed induction motor. Single-stage condensate pumps will function against a total head of 225 ft., and air will be removed from the condensers by evacuator steam-jet pumps.

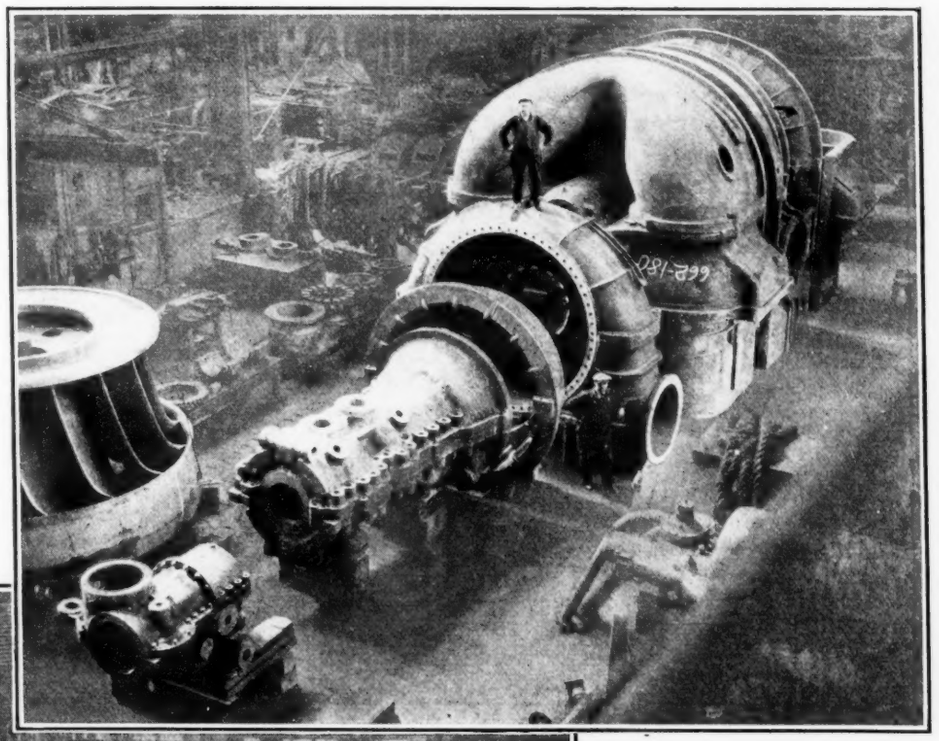


Fig. 2—Steam end parts of 50,000-kw. Waukegan turbine laid on shop floor

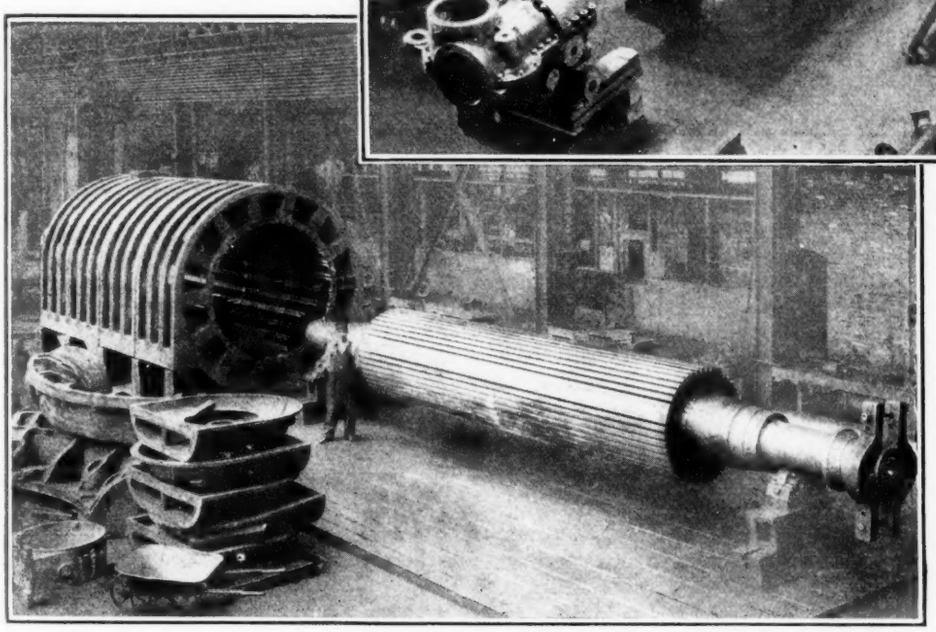


Fig. 3—Slotted rotor and stator yoke of 50,000-kw. 1,800-r.p.m. generator

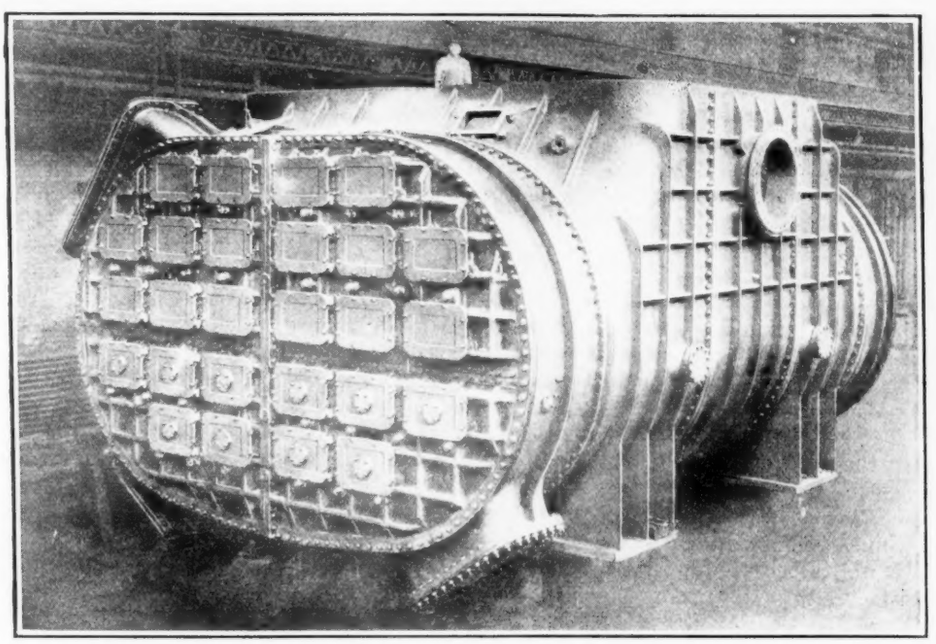


Fig. 4—Surface condenser serving unit—57,000 sq.ft. of surface

Frosting of Air Machines

Why Moisture Appears in Compressed Air—Influence of Atmospheric Humidity —Benefit of Stage Compression

By WILLIAM V. FITZGERALD

IN CONSIDERING the question of moisture in compressed air it may be advisable to discuss the general make-up and properties of air and touch upon some of the laws governing its behavior.

In its usual form air is composed of several gases, among which are nitrogen, oxygen, and other gases such as neon in very small proportions. In addition to the various gases atmospheric air carries with it a certain amount of water vapor.

The water vapor is the result of evaporation of water from the liquid state. It is not a part of the air, but forms a mixture with the air. Water vapor in air is not dependent upon air for its presence, but rather exists there as a separate element, although it is sometimes assumed, erroneously, however, that water vapor exists in air because of the air and depends upon air for its support as a vapor.

THAT compressed air contains moisture is evidenced by the wet conditions at the point of use, by the wet condition of the exhaust of tools where it is used as a driving power, and sometimes by the presence of frost at the exhaust. One sometimes wonders just why there should be moisture in compressed air and an explanation of the steps leading up to its presence in the air and the reason for its manifesting itself at the tool exhaust may be enlightening.

All liquids, if placed in a vacuum, will evaporate to a certain extent, depending upon the temperature. This evaporation will continue until the pressure in the vacuum chamber has reached the point where the liquid and vapor are in equilibrium. The amount of water vapor that may be contained in a cubic foot, or in any given volume, is determined by the temperature solely. A rise in temperature will permit the space to hold a greater weight of water vapor at a high pressure, whereas a decrease in temperature will precipitate some of the water vapor and the pressure will decrease. The weight of the water vapor in a cubic foot, therefore, varies with the temperature and the vapor pressure.

At a given temperature a definite weight of water vapor will evaporate into a cubic foot of space. At the same temperature a definite weight of dry air, exerting a fixed pressure, will occupy a cubic foot of space. The two, one a vapor, the other a gas, may both be confined in the same cubic foot of space. The weight of the water vapor plus the weight of the air is the weight of the mixture, while the original vapor pressure plus the original air pressure is the new pressure of the mixture. None of the water vapor will be precipitated or changed in any way by the mixture with the air, nor will it in case the air pressure is increased by the introduction of more air.

That is, if a liquid is open to a vessel that contains a volume of dry air, the evaporation takes place exactly as it did in the vacuum until the pressure in the vessel has increased by an amount equal to the vapor pressure of the liquid for that particular temperature. Both the air and the water vapor have the same individual pressures as they would have if they occupied the same space alone. This is known as Dalton's law and may be stated as follows: When a vapor and a gas, or two vapors, or two gases, occupy the same volume, the total pressure will be equal to the pressure that would be exerted by the gas alone added to the pressure exerted by the vapor.

Compressing air, it will be observed, is not merely a problem in handling the air as a mixture of oxygen, nitrogen, neon, etc.; but it is a problem of handling water vapor, in addition to the first-mentioned gases.

All free air contains some moisture depending upon the temperature of the atmosphere. There are two ways in which moisture in the air may be considered. One of these is the actual amount of water that is present in the air at any given time, based upon consideration of a specific volume of air. The other is the percentage of moisture actually contained in the air compared to the amount of moisture that can exist as water vapor at a given temperature. This is given in terms of relative humidity.

This leads to the question as to why the relative humidity of atmospheric air varies so widely. It is known that the humidity generally varies between 50 and 75 per cent, and sometimes reaches 100 per cent, causing precipitation as dew. It is also known that at certain places on the earth's surface the general run of relative humidity percentages is exceptionally high, while at other places they are unusually low. It may be asked why, at a given temperature, the relative humidity is not always the same. It may even be asked why the relative humidity is not always 100 per cent. If the temperature were maintained constant for a sufficiently long period, the humidity would reach 100 per cent, but the air temperature is constantly changing.

When air is drawn into the cylinder of a compressor, it may have a relative humidity of 50 per cent or 75 per cent or even 100 per cent, based on the prevailing temperature. In the first case it contains one-half the moisture that it can hold before any will settle out as dew.

The introduction of the air into the compressor cylinder changes the conditions of volume and temperature. Once the piston starts upon the compression stroke,

the volume of the air diminishes and the pressure begins to rise. This rise in pressure is important only because it is accompanied by an increase in temperature and a reduction in volume. Ordinarily, the reduction in volume would tend to throw out some of the moisture in the air. In the case of the air being at a relative humidity of 50 per cent, the pressure rise and consequent volume reduction would tend to decrease the carrying power of the air, or, in terms of relative humidity, it would raise the percentage of moisture in the air, and when the volume was decreased one-half, the humidity would be 100 per cent.

However, there cannot be a rise in pressure in compressing air without a corresponding rise in temperature. The rise in temperature increases the moisture-carrying capacity of the air and the temperature rise is sufficient to prevent the loss of volume having its effect upon the condition of the water vapor in the air. Therefore, the moisture in the air does not reach 100 per cent or even remain at 50 per cent relative humidity, but decreases rapidly. In this way, no precipitation can take place within the compressing cylinder.

How Moisture Behaves During Compression

Some idea as to how the moisture taken into the compressor behaves during compression may be gained by studying the tables. In Table I adiabatic compression of 1,000 cu.ft. of air at 60 deg. F. and 100 per cent saturated water vapor is shown. It will be seen from

TABLE I—ADIABATIC COMPRESSION

1		2	3	4	5	6
Pressure		Temperature During Compression, Deg. F.	Volume During Compression, Cu.Ft.	Weight per Cu.Ft. of Saturated Water Vapor at Air Temp., Lb.	Weight of Water Vapor Actually in Air, per Cu.Ft., During Compression, Lb.	Relative Humidity $\frac{\text{Col. 5}}{\text{Col. 4}} \times 100$
Lb., Gage	Atmospheres					
0.0	1	60	1000	0.000829	0.000829	100.0
14.7	2	175.8	612	0.017	0.00135	8.0
29.4	3	255.1	459	0.079	0.00181	2.3
44.1	4	317.4	374	0.1953	0.00222	1.1
58.5	5	369.4	319	0.3775	0.00260	0.7

column 4 that the amount of water vapor that may be held in the air, even at the reduced volume, increases rapidly with the rise in temperature.

While it is usual to speak of relative humidity only for temperatures common to atmospheric conditions, the term has been applied to the extended range of temperatures. The relative humidity or ratio of actual weight of water vapor per cubic foot to the weight of saturated water vapor per cubic foot, diminishes rapidly, so that at the discharge temperature the water vapor is only approximately 0.7 per cent saturated.

In isothermal compression, Table II, the compression of the volume of air at 60 deg. F. and 100 per cent relative humidity is shown to be radically different. In this case the temperature is constant while the volume diminishes according to the formula PV = constant.

Under these conditions the 100 per cent humidity rapidly rises to 500 per cent, and $\frac{4}{5}$ of the vapor is precipitated by the time the stroke is completed.

Now, there is a wide divergence between the results shown for adiabatic and isothermal compression, as far as the effect upon the moisture in the air is concerned. In actual compressor operation temperature conditions approach the adiabatic rather than the isothermal.

Discharge temperatures of 300 deg. F. are not at all uncommon in air-compressor work when compressing to 80 or 90 lb. gage in a single stage, in spite of the water-jacketed air cylinders. Especially is this true when compressors are run at high speed.

It is obvious, therefore, that the relative humidity at these compression pressures, even for air in its most humid condition, is so low that no condensation can possibly take place within the compressor cylinder.

Subsequent to the compression the air is passed to an intercooler, where much of the heat of compression is eliminated. In the intercooler there is no appreciable drop in pressure, whereas the temperature is lowered as much as possible. In this stage of the compression the air loses much of its moisture-carrying capacity owing to reduction in temperature, and before it leaves the intercooler for the second-stage cylinder,

TABLE II—ISOTHERMAL COMPRESSION

1		2	3	4	5	6
Pressure		Temperature during Isothermal Compression, Deg. F.	Volume During Isothermal Compression, Cu. Ft.	Weight per Cu.Ft. of saturated Water Vapor at Air temp., Lb.	Actual Weight of Water Vapor in Air During Compression, Lb. Col. 3 × Col. 4	Percentage of Water Vapor precipitated During Compression
Lb., Gage	Atmospheres					
0.0	1	60	1000	0.000829	0.829	0.00
14.7	2	60	500	0.000829	0.4145	50.00
29.4	3	60	333⅓	0.000829	0.2763	66.67
44.1	4	60	250	0.000829	0.2072	75.00
58.5	5	60	200	0.000829	0.1658	80.00

it is not only in a state of 100 per cent relative humidity, but has actually precipitated some water vapor in the form of liquid in the intercooler.

Assuming that the air that has been compressed to five atmospheres is cooled to 60 deg. F. in the intercooler, only 0.319 of its original water-vapor content can be retained as vapor in this condition. Theoretically, in the cooled air (originally 1,000 cu.ft.) there remains only 0.324 lb. of water vapor as compared to the original weight of 0.829 lb.

Saturated Air to Second Stage

Theoretically, the air enters the second-stage cylinder at a temperature approximating the temperature of the air entering the first-stage cylinder. In this way the general compression curve is kept near the isothermal rather than the adiabatic. Therefore, the air entering the high-pressure cylinder is saturated air at quite low temperature, as compared with air at 50 per cent saturation entering the first-stage cylinder at the same temperature.

With two-stage compression the air is passed from the second-stage cylinder into an aftercooler, where it is again cooled and the excess moisture precipitated. From the aftercooler the air may be passed to a receiver where subsequent cooling may precipitate more moisture. The air is essentially in a state of saturation, or 100 per cent relative humidity, by reason of its reduced volume and temperature.

The air fed to tools or air-using machines is in a state of saturation unless means have been employed for preheating the air prior to its use. In the event that a preheater is used, the air will be raised in temperature and the relative humidity will be reduced to a fraction of its 100 per cent prevailing in the receiver or lines leading to the tools or machines.

One would naturally expect that even without preheating the compressed air before using it, little or no moisture would be present at the exhaust from the tools. This, however, is not the case, although little or no condensation occurs in the cylinder of the tool,

owing to the fact that most air tools work on full stroke, at the intake pressure. No expansion of the air is permitted, and consequently there is no reduction in temperature and no chance for moisture to drop out.

At the exhaust a different condition prevails. Here, the air expands to atmospheric pressure and increases its volume, but decreases in temperature. If the expansion through the exhaust connections be adiabatic, conditions will be the reverse of those shown in Table I, and the final temperature, assuming 60 deg. before exhaust, would be far below freezing, causing all the moisture to frost. The volume of a cubic foot would increase to approximately 3¼ cu.ft., and the humidity would be over 100 per cent. Exhaust is not truly adiabatic, being nearly a constant heat process, and the temperature may be well above 32 deg., but even in this event the air is over 100 per cent humidity and part of the vapor settles out as drops of water.

When air of high moisture content is introduced into the first-stage cylinder, the intercoolers of the first and second stages become very wet and some of the condensed moisture may be swept along into the succeeding cylinders in the form of water.

It may be said in general that moisture in average commercial compressors, while present in the air at all times, appears as water only in the intercoolers and receiver and at the exhaust.

Three conclusions are arrived at as follows: (1) Air of any normal humidity at atmospheric temperature will reach the 100 per cent condition if passed through one or more stages of compression; (2) no precipitation can occur in any cylinder of any stage of compression even with 100 per cent humidity in the intake air to that cylinder; (3) there is always precipitation at the point of use of compressed air unless the air is preheated at or near the point of use.

Importance of the Fillet

By Capt. H. C. Dinger, U.S.N.

IN OBSERVING failures and breakages in mechanical apparatus and also in investigating defective castings, one is impressed with the importance of having proper fillets and also with the fact that in a large number of cases such fillets are not present. Many times these would have avoided failures or given sound instead of defective castings.

Nature is perhaps one of the best engineers. If one examines nature's structures it will be found that all strength members are well filleted. Take for instance the structure of bones. Not a sharp angle is to be found anywhere. All curves are easy, with no abrupt changes of direction that tend to develop a point of weakness or a place where a crack is likely to start.

Draftsmen and designers often do not seem to appreciate thoroughly the importance of having suitable fillets. On many drawings there are no indications that fillets should be put in corners, and often sharp angles are delineated with nothing to indicate that such angles are to be relieved by means of a fillet. Of course, an excuse may be offered that there is plenty of margin for safety and that it is expected that the patternmaker, foundry or shop will put in fillets where required. If the shops have definite instructions where and how to put in fillets, this may answer, but it would appear to be better to have the drawing indicate what is desired in regard to fillets.

Filleting is specially important where great strength and lightness are required and where the member is subjected to shock or intermittent loads. Here the intelligent use of fillets will enable a much lighter design to be used.

Now who is primarily responsible for bad filleting? The designer. If the designer does not make his wants known on such an important matter, how can he expect the shop organization to look out for this? Of course a well-regulated shop will often make up minor deficiencies of detail not indicated on drawings. The shop, however, cannot go very far in this matter without danger of running into trouble.

Drafting room, foundry and shop should have standing instructions regarding the use of fillets in order that this important matter can be handled intelligently and that unnecessary breakages, caused by the lack of proper fillets, may be avoided. The pattern shop should have special instructions to provide for adequate fillets at all important points, whether the drawing requires it or not. The foundry also should be on the lookout for further improvement and extension of filleting. Here fillets are desired for a double purpose—to get good castings and to avoid the starting point for a crack or fracture. The machine shops also should have standard instructions to make fillets on all sharp corners where this can be done and in particular to put them on keyways, slots, collars, etc.

The concentration of stress at a point in any material where a change in section occurs and no fillet exists is probably about two to one, and in many cases considerably more. There are various formulas for determining this, but it is complicated because the stress concentration is dependent on the various physical characteristics of the material, the sharpness of change of section, and the degree of change. With properly designed fillets this concentration of stress can be overcome and dangers of failure entirely eliminated.

Some of the serious breakages due to bad filleting may be mentioned.

Turbine blades—Inadequate filleting at the roots of forged and machined impulse blading is responsible for many serious blade failures. Proper filleting does not add materially to the cost. Why not employ it?

Keyways on shafting—How many of these have the sharpest corners possible? Hence is it to be wondered why they break away?

The original design of crankpin housing of the "Liberty Engine" failed largely because of poor filleting.

Bolt heads—These snap off because they are not filleted and sometimes even are undercut. All manner of crank arms break for the same reason.

In Any Industrial Works requiring both power for driving machinery and steam for process work, the maximum economy is obtained by selecting such a steam pressure and superheat for the boiler plant as will permit all the power required to be obtained by passing all the steam through turbines or engines which will deliver to each of the various processes the steam required at the correct pressure and temperature. No steam must be reduced to a lower pressure without being used for power generation, and no heat must be rejected to condensers or to atmosphere. Briefly, all power must be generated as a byproduct, no heat degraded, and none rejected to waste, using all exhaust in process work.—*Mechanical Engineering.*

Finding the Pressure Drop in Piping

By Frederic C. Evans
Assistant Professor of Heat Power Engineering, Cornell University

THE accompanying chart was designed to assist in making the power-plant piping study described by the author in *Power* for Nov. 2, 1926, p. 662, entitled "What Is the Most Economical Size of Power Plant Piping?" One of the important factors in that analysis was a determination of the drop in pressure in the pipe line, and this calculation lends itself to solution with the aid of an alignment chart, with accuracy as great as the equation justifies. For first the form of equation used is correct for small pressure drops only; secondly, there is serious difference of opinion as to the best coefficient of friction to use; and, thirdly, the equivalent length of pipe to allow for fittings, bends, etc., is somewhat indefinite. As a result the computations can be regarded as giving only approximate results.

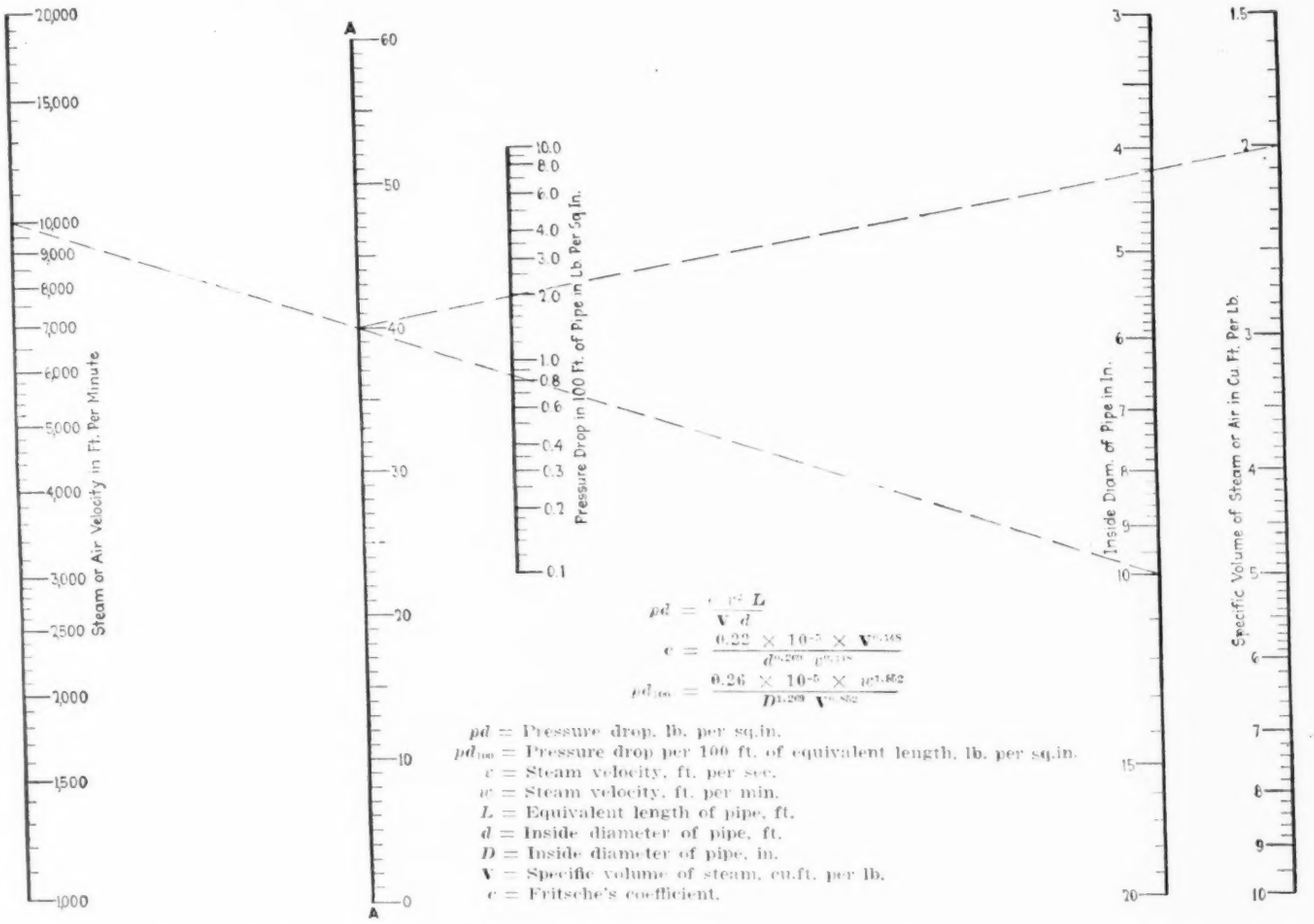
In the foregoing article it was stated that Fritsche's coefficient used in conjunction with the usual flow equation gave probably as reliable results as any for pipe lines carrying superheated steam under moderate pressures. The equations given with the chart are in slightly different form from those of the previous article, but they are equivalent.

To illustrate the method of using the chart, suppose it is desired to find the pressure drop per 100 ft. of 10-in. i.d. pipe carrying superheated steam having a specific volume of 2 cu.ft. per lb. (as found from steam tables or charts), and flowing with a velocity of 10,000 ft. per min. A straight line connecting the steam velocity (10,000) with the inside pipe diameter (10) determines an intersection on the axis labeled *AA*. This scale is graduated in arbitrary units that have no meaning, but facilitate the location of reference, or "pivot," points. In this example the pivot point is noted as 40.0. A straight line connecting this point with the specific volume of the steam (2) cuts the pressure-drop scale in the result desired, 1.98 lb. per sq.in. per 100 ft. of length.

If the desired pressure drop is known, the chart, of course, can as readily be used to find the pipe size required for a given flow. With any three of the variables known, the fourth can be found.

Although the chart, as constructed, is for the flow of superheated steam, the coefficient and the flow equation also apply to the flow of air. This chart, then, can also be used in problems involving the transmission of compressed air.

Since the equation is applicable only to cases involving a small pressure drop, the steam or air velocity and specific volume may be taken at any convenient point. The variation of these quantities along the pipe line should not be sufficient to affect the results materially.

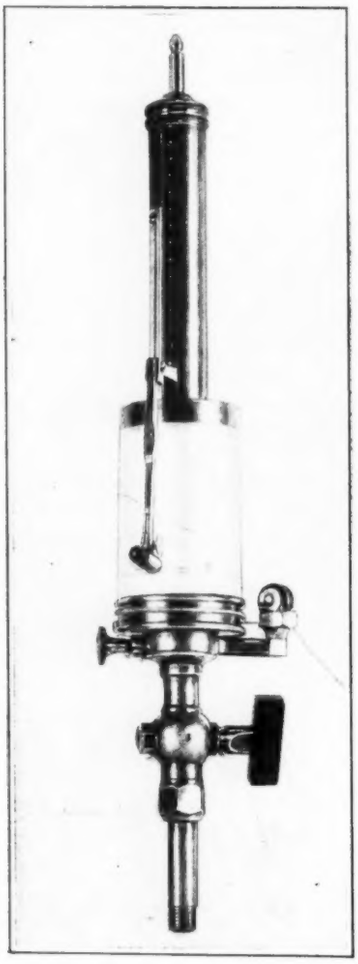


$$pd = \frac{c^2 \mathbf{V} L}{d}$$

$$c = \frac{0.22 \times 10^{-5} \times \mathbf{V}^{0.348}}{d^{0.269} w^{0.518}}$$

$$pd_{100} = \frac{0.26 \times 10^{-5} \times w^{1.852}}{D^{1.269} \mathbf{V}^{0.852}}$$

pd = Pressure drop, lb. per sq.in.
pd_{100} = Pressure drop per 100 ft. of equivalent length, lb. per sq.in.
c = Steam velocity, ft. per sec.
w = Steam velocity, ft. per min.
L = Equivalent length of pipe, ft.
d = Inside diameter of pipe, ft.
D = Inside diameter of pipe, in.
$\mathbf{V}$ = Specific volume of steam, cu.ft. per lb.
c = Fritsche's coefficient.



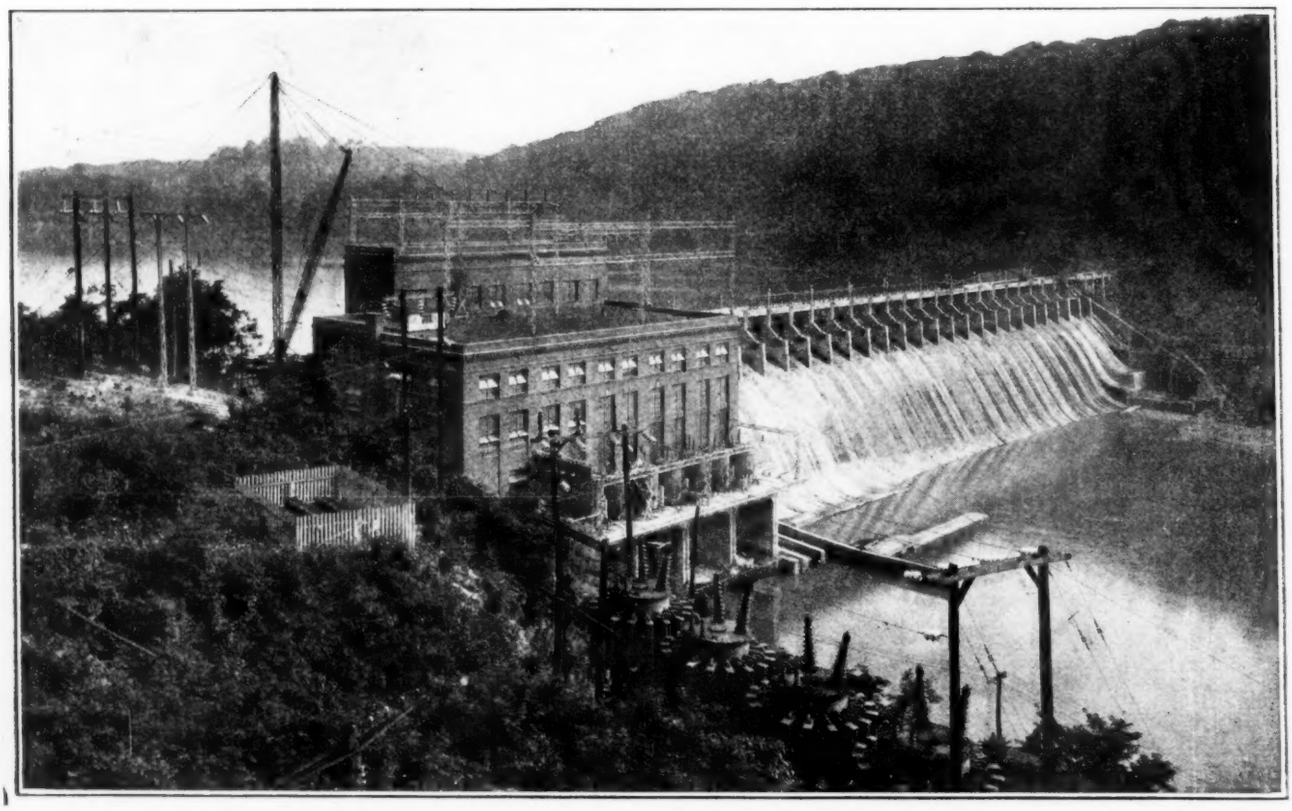
Old Indicator Still Works Perfectly

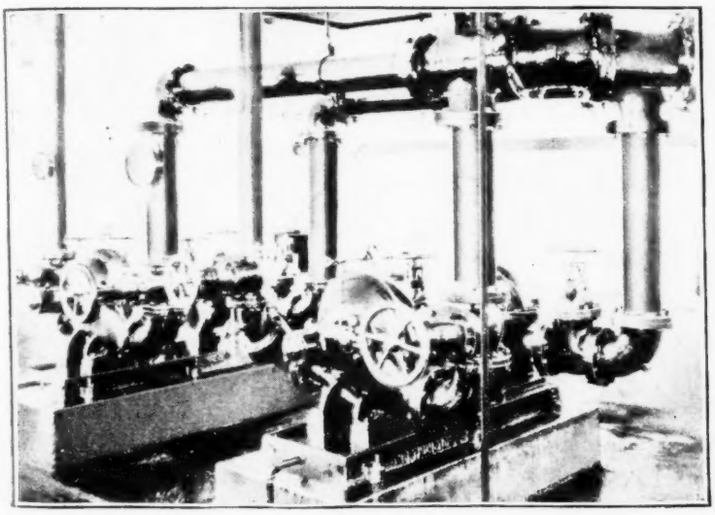
Left—Some obsolescence but no depreciation is visible in this indicator inscribed "Trafton 1842" by its maker, who lived in Worcester, Mass.

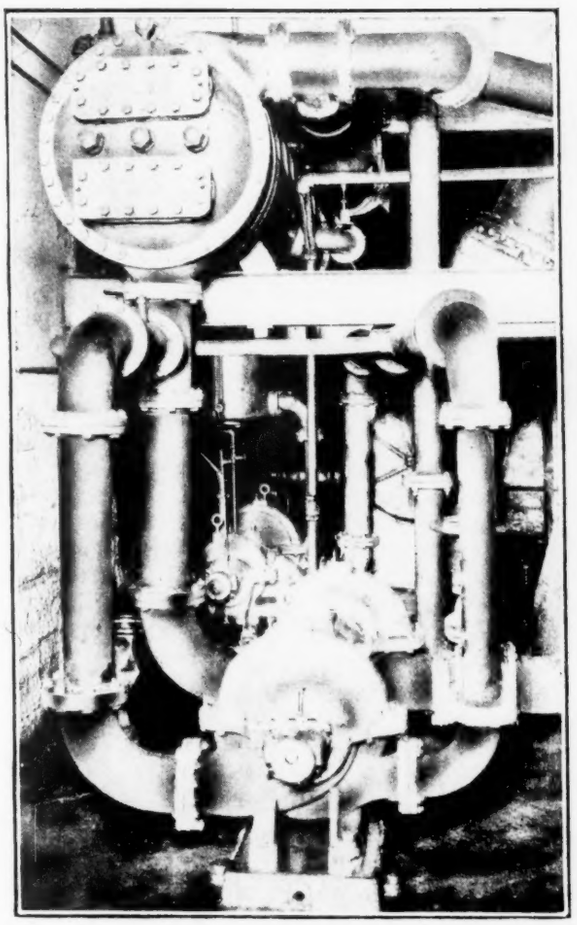
Still More Water Power

Above—A single impulse turbine will generate 40,000 hp. for the San Joaquin Light & Power Corp. (Calif.) in the new Balch power plant. The head is 2,380 ft.

Below—The recent installation of the fourth 16,000-kva. unit marked the completion of the peak-load Cheat Haven plant of the West Penn Power Company. The dam is 1,000 ft. long and 135 ft. high.







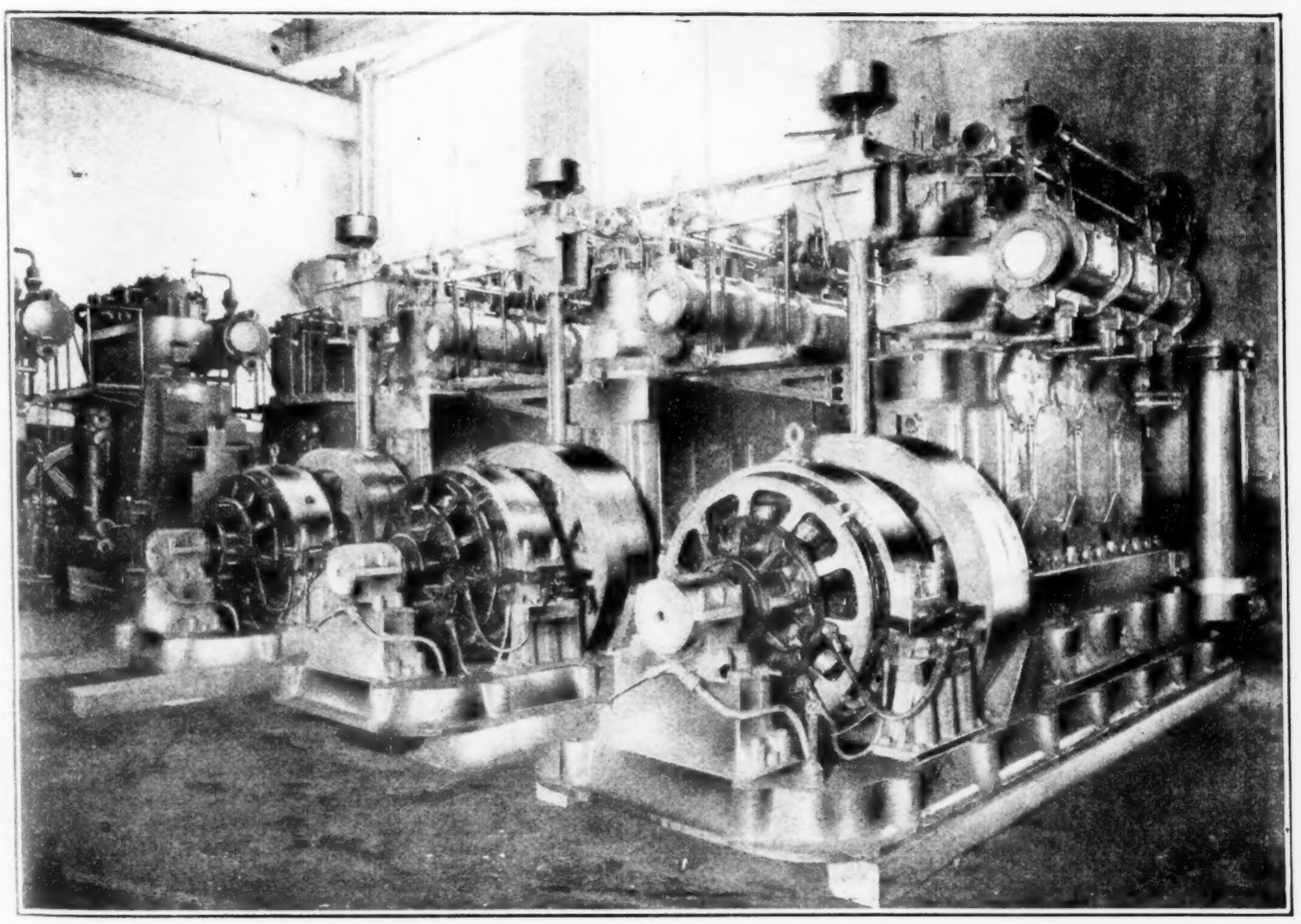
Waterwheels Pump Water

Waterwheels operated from the high-pressure mains are used by the Metropolitan Utilities District, Omaha, Neb., to drive centrifugal pumps handling filter-plant wash water (above) and condenser cooling water and condensate (right).

Diesels Will Drive American Ships

Part of the Shipping Board's initial order of Diesel engines in shop ready for shipment

Photos on this page by courtesy of Worthington Pump & Machinery Corp.



Thoughts on the Installation of Oil Engines

Practical Suggestions as to Points Frequently Ignored When an Oil Engine Is Installed—Avoid Scanty Foundations, Low Headroom, Long Exhaust Lines and Makeshift Oil Storage

PURCHASERS and sellers of oil engines do not give sufficient attention to the details of their installation. In contradiction to the accepted method of studying a steam-plant layout, too often the oil engine is placed on a foundation and put into service without any great consideration being given to the amount of foundation, location of the plant, exhaust lines, water connections, system of drive, etc.

Many builders' standard setting plans show a conventional foundation depth of six or eight feet, and

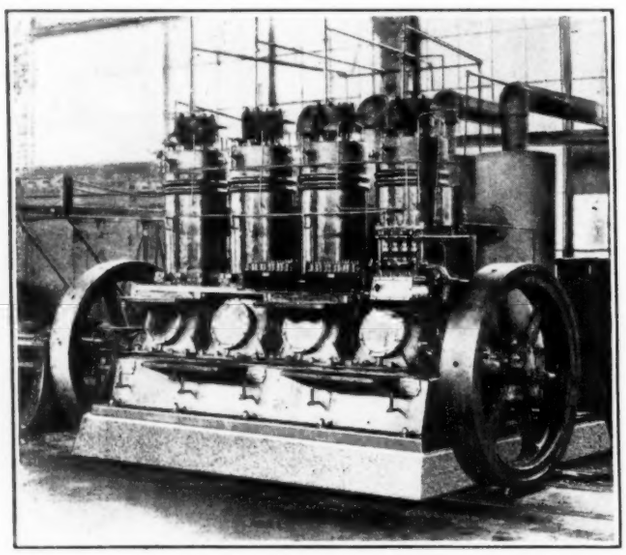


Fig. 1—An excellent example of short direct exhaust lines

frequently such plans are followed blindly by the purchaser, without regard to the character of the soil. The purpose of an engine foundation is more than merely to provide a bearing surface to prevent settling. The dead weight or static load of an oil engine will seldom exceed 400 lb. per horsepower, and the cylinder pressures are not transmitted to the foundation, for the downward thrust of the piston is counteracted by the upward pull produced by the action of the combustion gases upon the cylinder head transmitted through the tension bolts to the frame. There are, however, other forces which are unbalanced and which exert pressure on the foundation, these being the inertia forces of the reciprocating parts, the piston and connecting rod, and may equal the static weight.

A foundation must have a plan sufficient to withstand these pressures without settling. For example, in one case a four-cylinder vertical solid-injection engine rocked violently on the light foundation upon which it was set. The trouble was overcome by enlarging the concrete mass.

Contrary to popular belief an engine need not be leveled up so that the cylinder axis is strictly horizontal or vertical. If the engine is belted to a shaft or a machine, the crankshaft should be level, but if the unit is self-contained, the absence of exactness in the leveling is not likely to cause future trouble. However, such alignment, or realignment at some future time, with the driven machine is made easier if the machines be initially leveled. An honest erector will see that the engine is properly leveled, and his general ability may be judged by his care in leveling the bedplate. After the engine and generator are finally set, the generator frame should be doweled to the engine extension subbase, or if a separate base be used, the dowels should go into this.

Belted engines require that the crankshaft be level if the shaft of the driven machine be level, and as a horizontal line is easiest established, it is usual so to set both engine and driven machine. If the two shafts are not in alignment, it is practically impossible to keep the belt on the pulleys.

Laying Out the Exhaust Line

The exhaust line is usually run outside the building with a vertical pipe reaching above the roof. At times little attention is paid to the length of line or to the diameter. In one waterworks plant in New York State, a four-stroke-cycle engine was installed. As the engineer's residence adjoined the pumping plant and the noise, as well as the fumes, of the exhaust gases were objectionable, the exhaust line was run horizontally 130 ft., followed by a 30-ft. stack. This, of course, put a back pressure on the engine, but as the piston on the exhaust stroke forced the gases through the pipe, the operation was satisfactory, although there was a loss in power. Later, a two-stroke-cycle engine was installed to drive a second pump, and the same exhaust layout was followed. This engine showed a high fuel consumption, ran hot and continually broke piston rings. Investigation revealed that the back pressure due to the long exhaust line was over 2 lb. per sq.in. The crankcase compression delivered air at 2½ lb., and it was obvious that the high back pressure prevented the thorough scavenging of the cylinder. At the beginning of the compression stroke more than one-half of the cylinder content was hot burnt gas. The final compression temperature became so hot as to cause cracking of the oil and carbon deposits. The engine could not carry its load because the air supply was

insufficient, the air change being less than one-half that contemplated by the designer.

Exhaust lines should in all cases be as direct as possible with the smallest possible number of elbows and the shortest length.

The air for the cylinders should be drawn from out-of-doors save in exceptional circumstances, although it is common to draw the air direct from within the building. In cold climates this may not only be a hardship upon the operators, but lead to engine trouble. Take, for example, a plant of 1,000 hp. located where the winter atmospheric temperature is 10 deg. below zero. About 10,000 lb., or over 100,000 cu.ft., of air are consumed per hour; this means that the room air is changed as frequently as once every five minutes.

Comfort requires a room temperature of at least 65 deg. F., which means that during zero weather somewhere around 100,000 B.t.u. must be added per hour to the air entering the building in addition to the building radiation loss, which is about twice this amount. This requires provision for heating by steam or hot water,

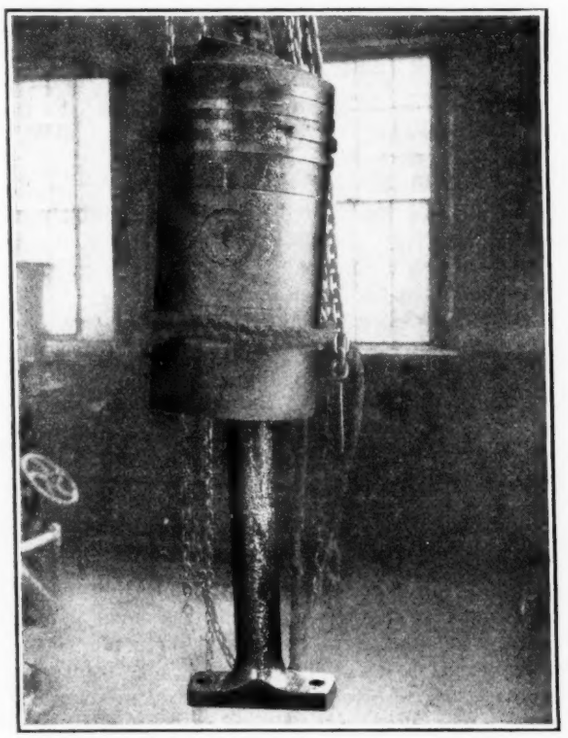


Fig. 2—Carbon on piston due to long exhaust pipe

which latter could be the engine cooling water, provided enough coils were installed along the room walls.

By drawing the air from without the building, the room air is not disturbed and a comfortable room temperature is obtained with much less heating.

Where the atmosphere is loaded with rock dust and the like, some manner of air filter should be installed.

Oil lines also are troublesome in cold engine rooms, and should be hot-water-jacketed if the air must be taken from within the room. While the intention may be to use only a light grade of fuel oil, price variation may encourage the purchase of heavier oils. The latter call for heating at all times of the year, and even light oils are not free-flowing during extremely cold weather.

Fuel storage to permit the purchase of fuel in carload lots is most important. The price differential between oil in barrel form and in tank-car lots is sufficient to pay for the storage in a short time. An example of disregard for this possible economy is found in an Eastern plant containing a 200-hp. Diesel operating 10 hours a day and using 100 gal. per day of 36-deg. Baumé oil. Delivered by wagon into a 200-gal. service tank, this oil cost 9c. per gal., although the oil company offered to supply it at 6c. if a 5,000-gal. tank were installed, a net saving of $150 each 50 days. A tank could be installed for less than $1,000, and a usable tank from a condemned tank car was procurable for $400.

Lubricating oil storage often consists of an oil barrel in the corner of the building, out of which the oil is drawn into a bucket or measure. The oil drippings make a floor most unsightly and embody a fire risk. Unsuitable arrangements such as these fail to impress the operating men with the value of the equipment under their care. Suitable oil storage and handling systems are not expensive and will save their cost by the decreased oil wastage.

An omission in installation which impresses itself upon the engineer is a matter of headroom. When pulling the piston of a vertical engine, the less laborious way is to withdraw the connecting rod with the piston, dissembling after the parts reach the floor. If ample headroom is not provided, it becomes necessary to drive out the piston pin and disconnect the rod as soon as the piston is clear of the cylinder. The labor is more than doubled, and the fitting of the pin bearing is especially difficult. One case was particularly glaring, inasmuch as the plant designer raised the engine about two feet above the floor level and left only four feet headroom above the engine.

Company Responsible for Damage Caused by Helper

In the recent case of St. Louis, S. F. & T. Ry. Co. vs. Kaylor, 284 S. W. 983, the Court of Civil Appeals of Texas held that a verdict for $12,325 was not excessive where it was shown that a mechanic's jaw was broken and that he suffered great pain and was unable to follow his occupation for several years.

The facts of the case are that the machinist who was injured had taken a position with his hands directly under his chin for the purpose of holding an object while his helper attempted to knock a binder down by striking it with a sledge hammer. The machinist was working in a very narrow place because of other construction, and after about six blows had been struck by the helper on the place designated by the machinist, the helper struck a blow far away from the intended place with the result that the block flew up with such great force and violence that it broke the machinist's jawbone, knocking out some teeth and injuring his upper jaw to such an extent that it necessitated the extraction of all his upper teeth. The injuries thus received are permanent and have disabled him from following his occupation as a machinist. The Court held that the injuries received resulted directly from the negligence of the helper in striking away from the designated place, and further that the injuries received by the machinist were not due to negligence on the part of the machinist himself. That is, the court did not find "contributory negligence" on the part of the plaintiff.

Financial Value of Muscle Shoals Power

By J. C. STILES*

IN THE near future the disposition of the government properties at Muscle Shoals will probably again be brought up for consideration. Many are interested in this matter. Comparatively few, however, are familiar with it except in a superficial way, and the number of persons having a clear conception of the potential value of the various items composing the property is still less. This is particularly true of the Wilson Dam power plant, and it is with the idea that many would be interested in having the financial value of this item plainly stated to them that this article has been prepared.

Power Available at Wilson Dam

As yet it does not seem to be understood by those seeking a solution of the Muscle Shoals problem that the power available at Wilson Dam that can be used advantageously by the associated power interest in the district where the plant is located is: In 1926, 450,000,000 kw.-hr.; in 1927, 450,000,000; in 1928, 650,000,000; in 1929, 1,000,000,000; and in 1930, 1,000,000,000 kw.-hr. Practically no additional expenditure, either by the government or by the power interests would be necessary to obtain these outputs. By making a small investment in additional transmission lines, these quantities can be materially increased.

Another matter affecting the power output of plant is the terms of the agreement under which it is leased or sold to the distributor. As for instance, with any agreement such as the present one, or one which provides for cancellation on short notice, the purchaser of power must, for self-protection, maintain sufficient generating equipment to replace, at any time, the amount of Wilson Dam power that is being used. Such conditions restrict the use of this power and materially reduce its value to a distributing company.

Cost of Producing Power

The unit value of this power based on over-all cost of producing power in this part of the country, is not less than 4 mills per kilowatt-hour. Figures for quantities of power available from Wilson Dam, and above unit cost, have been obtained from actual operation and operating costs and can be supported by reliable data. Using these figures as the basis of an estimate of power value, it is shown that the yield from Wilson Dam should be: In 1927, $1,700,000; in 1928, $2,600,000; in 1929, $4,000,000; and in 1930, $4,000,000.

In the first half of 1926 the output from the plant was limited by transformer capacity and test requirements. These conditions controlled the power rate for the year, which will average very little above 2 mills per kilowatt-hour. As the result of limited output and low rate the amount received for power for the year will be only about $900,000.

There are many combinations by which the present interconnected power systems in this district can be operated, and it is an easy matter either to prove or disprove the figures given; but by the writer they are believed to be a fair statement of what this plant will produce if permitted to do so.

Joint Congressional Committee

Compare these figures with the annual yields considered by the Joint Congressional Committee on Muscle Shoals as the most favorable bid for the properties. This bid offered to pay $600,000 per annum for the first six years, $1,200,000 per annum for the next six years, $1,500,000 per annum for the next six years, and $2,000,000 per annum for thirty-two years.

In investigating the worth of the power available from the Wilson Dam hydro-electric plant, full consideration should be given, not only to output available at present, but to the increase when storage dams are constructed and river flow regulated.

At a modest increase in power demand per year in the district served by the associated power interests, the year 1940 should see an increase of fully 100 per cent over present quantities and the amount delivered from Wilson Dam will obviously be materially greater as the demand absorbs more of the secondary power that can be produced at this plant.

Effects of Fertilizer Guarantees

If the bidders for these properties have taken into consideration the real value of Wilson Dam power, it would seem that fertilizer guarantees have been considered by them as liabilities to be deducted from the power value. If it is the intention of those interested in the solution of the Muscle Shoals problem to make an agreement whereby consumers of power shall pay part of the fertilizer bill, would it not be better to make a clean-cut agreement to that effect, with provision that if the production of fertilizer proves to be impracticable, the government shall be paid for the power thus released and made available for commercial distribution to industries in general?

Sometimes the best solution of a perplexing problem is arrived at by temporarily allowing events to take their natural course and not to create a premature determination. If this course is pursued and the present administrative government officials be given authority to operate or to make the most advantageous temporary disposition of power for a period not to exceed ten years, it will clear away some of the political haze that seems to surround this problem and have a tendency to bring to light its real value, thus eliminating to a considerable extent the temptation to which all are susceptible—trying to get something for nothing.

*From 1918 to 1923 the author was in the government service in connection with the construction and operation of the Warrior steam plant at Gorgas, Ala. From 1923 to 1926 he was employed on construction work by Hugh L. Cooper & Co., consulting engineers for the Wilson Dam project. Since the first of this year he has been in the government service doing power-study work under the district engineer at Florence, Ala.

Safety in the Power Plant

AT THE recent A.S.M.E. meeting there were five-minute talks on safety at all of the principal sessions. The subject is important, despite the fact that shortsighted men poke fun at it and heap contempt upon it.

Some years ago a turbine was wrecked by overspeed, and almost killed the operating engineer. Inspection disclosed that the governor had been removed because it occasionally tripped the machine out when the load dropped off, and it was too troublesome to restart the machine. The unit was rebuilt, with the governor in operation, of course, and ran peacefully for nearly two years, when it burst again, this time killing the engineer who had previously been injured. Inspection again showed that the governor had been rendered inoperative.

What can be done with such a man? Must he be killed to stop his tinkering with the governor? Every man who works in or about a power plant must be brought to appreciate that an ungoverned turbine is as bad a hazard as a barrel of dynamite and that any unintelligent interference with the proper functioning of the governor may endanger the life of everybody in the neighborhood. The man who will monkey with the governor should be quietly but effectively removed from any possibility of access to the power plant.

And the turbine governor is but one instance. Power-plant work is not especially hazardous for the intelligent operating crew, but they must work together. Each man must know what is going on about him, and be keenly alive to the fact that in certain of his daily duties he has the lives of himself and his associates in his hands. The man who lacks the skill or the sense of responsibility to be trusted in such a situation has no place in plant operation.

Industrial Power Receives Attention from A.S.M.E.

FOR some time it has been apparent that the activities of the A.S.M.E. Power Division must divide logically into central-station and industrial power practice; not from any competitive standpoint, but because one is highly specialized and the other includes many diversified factors. Moreover, advances in industrial power, from both design and operating viewpoints, during the last two years, have been such as to warrant separate attention. Accordingly, a session at this year's annual meeting was devoted to each.

Last year at the annual meeting a small group of industrial power executives gathered at a dinner to consider what might be accomplished. This year the group had enlarged to thirty-six, and four hours were devoted to discussion of mutual problems. The present status of this committee is entirely informal. Whether it continues in such capacity or becomes a standing committee is a matter to be decided later.

Unlike central stations, which produce a single commodity and have the Prime Movers Committee of the N.E.L.A. as a medium for the exchange of ideas and experiences, the industrial plants have no common yardstick for comparing performances and no body regularly constituted for the exchange of information. It seems, therefore, that such a subcommittee of the A.S.M.E. Power Division might, to a large degree, perform the latter function and perhaps, if given authority by the Society, might even set up some general system of records, flexible enough to be applied to the average plant, and serve as a means of comparing performance.

The opportunities loom large, but the foundations for the work of such a committee should be well laid, and progress must necessarily be slow at the start owing to certain handicaps and the diversities of power application.

Increasing the Oxygen Supply to Furnaces

A NEWS item recently stated that a process had been developed whereby it was possible to increase the oxygen content of air from 20.7 per cent by volume to nearly 25 per cent by passing the air through a new centrifuge. If this can be achieved with large quantities of air and with small power consumption, some interesting possibilities are presented to combustion engineers in connection with boiler operation.

In the first place, the quantity of air required for combustion with a given percentage of excess would be reduced about inversely as the oxygen content is raised. There would be a further reduction since a smaller percentage of excess air could be used owing to the more active chemical combining properties of the air with the higher oxygen contents. This reduced net air supply would permit the development of higher furnace temperatures. It is difficult to predict the probable increase in temperature as this would be influenced by the furnace and boiler construction.

The general effect of increased furnace temperatures is to decrease the flue-gas temperature leaving the boiler, and thereby to increase the boiler efficiency. A factor further tending to decrease flue-gas temperature would be the presence of a higher percentage of CO_2 in the furnace gases than is usual practice with the boiler furnaces where carbon is the principal content of the fuel. It is now well established that CO_2, when hot, emits radiant energy. Therefore, increased CO_2 would result in increased radiant heat transfer to the boiler tubes during the passage of the gases through the boiler. This, as indicated, should further reduce flue-gas temperatures.

Smaller volumes of flue gases resulting from increased oxygen require smaller breechings and stacks, or, if in-

duced-draft fans are used, these could be made smaller and would require less auxiliary power.

Economizers always produce the greatest savings when the weights of flue gases are excessive. Hence the reduction of the weight and temperature of the flue gases leaving the boiler would decrease the possible savings by the use of the economizer. The air preheater, on the other hand, would be affected only slightly, if any, by the lowered temperature, for there would be proportionately a lesser amount of air to preheat by the reduced flue gases.

Standardizing Motor Dimensions

STANDARDIZING work, as approved by the American Engineering Standards Committee or as carried on under the name of "Simplified Practice," through the United States Department of Commerce and also as sponsored by other agencies, is going ahead rapidly and is of far-reaching effect. These standards have been a great benefit to progress in practically every line of human endeavor, notwithstanding the argument generally raised, that standardization retards progress. There is no doubt that standardizing can be carried to a point where it will retard progress, but up to the present time the tendency has been to keep within conservative limits. Furthermore, a standard once established is not irrevocable, but can be changed when the progress in any art warrants; and many of the early standards have been altered to meet new conditions.

In the design of electrical machinery, certain standards have been established for temperature rise, quality of insulation, machine rating, methods of testing and many others. By the wildest stretch of imagination these cannot be shown to be a ban to progress, but quite the contrary is true, as the development of the electrical industry is the outstanding wonder of modern times. These standards of performance that all manufacturers are required to meet have been of great benefit to the user, and at the same time the designers have been left free as to methods of meeting them.

Although there have long been standards for electrical machine performance and rating, standards for the outside of the machine have made little progress. The question of interchangeability of motors of the same rating has become highly important, particularly where the motor is built in as part of the machine it is driving. When a motor fails, it is generally desirable that it be immediately replaced. Where it is built into the machine, with the present hodgepodge of dimensions, unless an exact duplicate of the motor is available, this replacement generally cannot be made.

A few simple dimensions, if standardized, would make interchangeability possible, would greatly simplify the problems of the various machinery designers, who have to provide space for the motor in their designs, and would simplify the work of maintenance. These dimensions are the spacing of the holding-down bolt holes, height of shaft centers and size of shaft extension and keyway. The size of shaft extensions and keyways have already been established by the Electric Power Club.

It is difficult to explain why there has not been standard-size bolt holes in the feet of motors of given ratings. This statement also applies to a certain extent to other dimensions. The time has come when something should be done, and it is desirable that everyone interested should co-operate in the present movement authorized by the American Engineering Standards Committee to standardize certain motor dimensions. There may be sound economic and engineering reasons why this should not be done, but until these are established there is no justification for evading the issue.

Engineers Should Follow Henry Clay

THE title of "The Great Compromiser" was bestowed upon Henry Clay for his willingness at all times to shape his policies to conform with the exigencies of the occasion.

On the surface there may seem little connection between this characteristic of Henry Clay and the engineering profession. Still, if an engineer is to be successful, he must not be too firm in maintaining his conclusions to any problem. Engineering is often spoken of as an exact science, and the engineer is popularly thought of as one who deals with hard cold facts, from which but one, the accurate, conclusion can be drawn. On the contrary, the practice of engineering is not exact and frequently there are a half dozen possible conclusions, any of which will lead to success.

In many cases the engineer must adopt a compromise solution, and he is making an inexcusable blunder when he insists too strongly on the rigid following out of any one conclusion, even though it seem the sound one on strictly engineering considerations.

For example, on considering an air compressor the engineer might reasonably insist that the machine should have four stages. There is in favor of four stages a high thermal efficiency and a high volumetric efficiency. On the other hand, this design results in increased valve losses and to a lesser degree increased mechanical losses. In favor of fewer stages there is increased mechanical efficiency and less valve loss, but the thermal efficiency is lower, as is also the volumetric. What so often happens is that a compromise of, say a three-stage machine is adopted with the result that the comparatively high mechanical efficiency and small valve loss make the machine the best solution in spite of the fact that its thermal efficiency is slightly lower than that of a four-stage machine and its volumetric efficiency somewhat lower.

Similar citation can be made as to conditions in every field of engineering design and operation.

Unfortunately, not all have grasped this truth, and so at different times engineers who are too thoroughly convinced of the absolute truth of their ideas, insist on a rigid adherence as a matter of principle. The result, unfortunately, is that a highly valuable man resigns in protest, to the financial loss of both himself and his employer or client. One should fight for one's ideas, but when victory is not in sight, one should be willing to compromise. In engineering as in charity a half-loaf is better than no bread.

THE PRESIDENT'S RECENT MESSAGE to Congress appears to commit the Administration to regulation of the coal industry, in that the Chief Executive requests authority to appoint mediation boards, apparently with power similar to those of the Railway Mediation Board, and requests also provision for emergency distribution and, by implication, for the control of prices. This would appear to be in anticipation of a probable strike in the bituminous industry next spring.

Practical Ideas From Practical Men

Locating Belt Holes in Floors

In many power plants the engineer in charge is often called upon to carry out work necessitating holes being cut in floors for the passing of driving belts, the actual cutting being done by a handy man or carpenter who, if left alone, does some puzzling and head-scratching

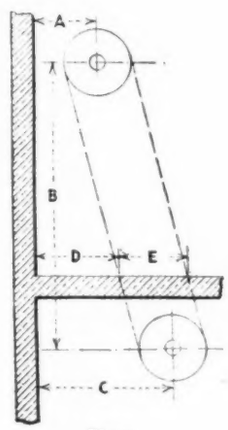


Fig.1

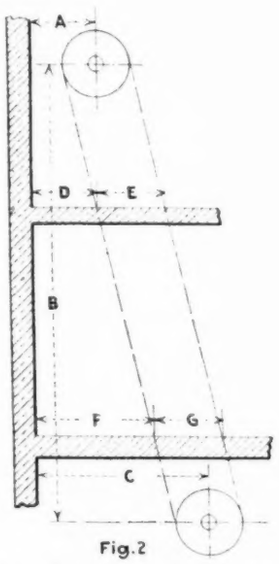


Fig.2

Dimensions to be obtained when laying out holes

and then goes wrong, leaving behind an unsightly mess or a lot of patchwork.

Many years ago, when a boy, I happened to be assisting a real old-timer at this work, and, no doubt to help me along, he gave me the job of marking off a dozen or so of these holes, at the same time giving me instructions that proved simple and successful, and this old-timer's method still holds with me whenever this job crops up.

There are, of course, various formulas to obtain the desired result, but most of them require "the multiplying of quotients by half the sum of certain diameters," or something of the sort likely to confuse the layman, or he does not grasp it at all, and the old-timer's method may be of interest.

This requires a rule or tape measure, a piece of chalk and string, a straight line upon the floor, or a suitable board, and a lath for use as a straight-edge. The first move is to obtain the dimensions *A*, *B* and *C*, as shown in Fig. 1, taking care when measuring *B* to locate exactly the floor position. Then from a line upon the floor or the edge of a board, chalk in the shaft centers and, with the chalk and the string for trammels, mark off the circles or pulley diameters. When this has been done, mark the lines of belt travel, and the correct position of the floor to be cut; or in other words mark off the dimensions *D* and *E*; then with a plumb-line from the pulley edge the correct position can be marked on the floor.

The same method applies when two floors have to be opened, the additional dimensions *F* and *G* being found and marked off on the floor.

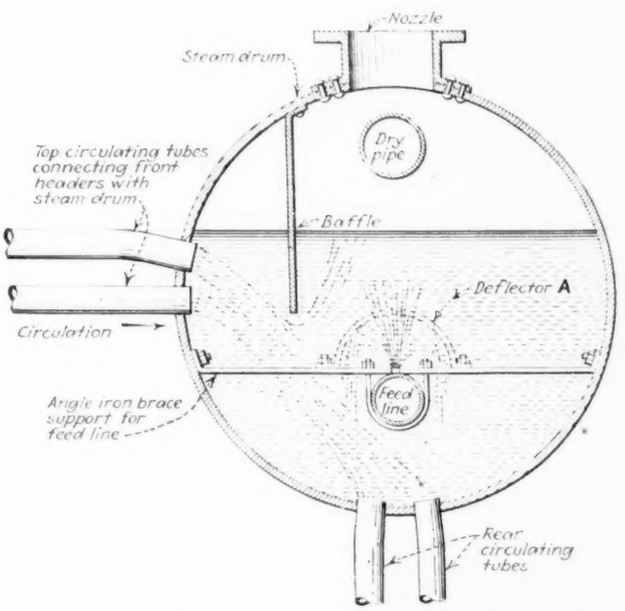
With practice it will be found that little time is required for the job, and should floor space not be available, a drawing to scale can be made on paper and dimensions *D* and *E* transferred to a lath and passed on to the workman doing the job.

F. P. TERRY.

Belfast, Ireland.

What Made the Tubes Blister and Burn Out?

We recently had a lot of trouble with the tubes burning out in the bottom row of a water-tube boiler. The boiler was equipped with a chain-grate stoker burning anthracite, bird's-eye size. The distance from the bottom row of tubes to the grate was about 20 ft. The



Cross-section of boiler drum showing arrangement of circulating tubes and feed pipe

boiler had been in operation only two weeks when 20 tubes had to be renewed and three weeks later 14 tubes were renewed. In both instances some of the tubes were burned through and others were badly blistered. After the boiler was erected, it was boiled out thoroughly, cooled down and washed out. Six weeks after erection 9 tubes had to be renewed.

While this work was being done, it was noticed that some of the previously renewed tubes had failed as well as some of the original tubes. It was also noticed on some of the sections of the tubes that the blisters were

6 or 8 in. apart, some sections having as many as ten blisters. We concluded that the trouble was due to sluggish circulation in the bottom row of tubes, and so we started an investigation to determine what the cause might be.

The boiler was fed through a 4-in. feed pipe that extended through the steam drum from head to head. The water was supplied from one end only, and the holes in the pipe pointed upward toward the dry pipe, as indicated by the full lines in the sketch. It appeared to us that the water entering the boiler was breaking the circulation in the boiler. We first connected the feed pipe to feed from both ends of the drum, but this did not help matters any, as tubes continued to burn out every week or two. It was then decided to put a half-round deflector *A*, as indicated by the dotted line, above the feed line, extending from head to head to deflect the incoming water into the same general direction as the natural circulation in the boiler. The deflector was made from a piece of 6-in. pipe cut lengthwise. Half-round straps with flat ends were electrically welded to the sections of the pipe and bolted to the angle-iron braces which supported the feed line as shown. Each end of the deflector had a blank welded in it to prevent the water from striking the drum heads. The deflector has been in service for a considerable time now, and the tube troubles have diminished appreciably. There was also an increase in the temperature of the steam after the deflector was installed. ELLIOTT E. SMITH.

Scranton, Pa.

Who Should Buy Power-Plant Instruments?

For years I have owned a steam-engine indicator and more recently have procured a portable set of combustion instruments consisting of a draft gage, flue-gas thermometer and CO_2 analyzer. I consider the money so spent a good investment, having more than once had my salary raised on the strength of being able to accomplish more with my instruments than had ever been done without them.

From information given by my indicator in one plant, I had only to lengthen the valve rod of a piston-valve engine half an inch to permit carrying additional load, thereby saving the owner the cost of a new 75-hp. motor that he was on the point of buying. My flue-gas thermometer has shown up scale and short-circuiting of gases where such conditions were never before suspected, and from that time on the coal bill was naturally less.

I took my CO_2 equipment into a friend's plant after he told me he wanted steam jets to blow air above the fire to get better combustion. We found by means of gas analysis that he was already getting 100 per cent excess air through defective brickwork that looked all right to the casual eye. Naturally, no jets were installed and after a few leaks had been plugged, 14 per cent CO_2 was obtained.

The point I wish to stress is that it is not fair to expect the average engineer to buy these instruments when the employer is the one who derives the most benefit from them. True, the engineer may get an increase of five dollars a week by using the instruments effectively, but that means that the owner is getting several times that much due to the engineer's efforts. The cost of a portable outfit is less than one hundred dollars, and any boiler plant can afford one, for if only one-quarter of a ton of coal is saved a week, the cost of the three necessary boiler instruments is saved every year the plant runs. There are but few industrial plants whose fuel consumption is below ten tons a week, and the saving required to pay for the instruments in a year is therefore 2½ per cent of the fuel formerly consumed.

It must not be thought that a plant must be badly run down in order for it to be possible to cut the coal consumption 2½ per cent, for even in a plant using the best type of stokers but operating without instruments, I believe that this much can be saved. Even a plant with a small boiler operated day and night at an average normal rating during the heating season of seven months, will consume probably 750 tons of coal, costing $5,250. A saving of less than 2 per cent will justify the purchase of one hundred dollars worth of instruments, and if handfiring is used, it is a certainty that this 3 per cent can be saved. The burdens of the engineer are great enough and his pay in many cases so low as to prohibit his purchasing even a portable set of boiler instruments, regardless of how thoroughly he is sold on the idea. The employer is the logical purchaser because he gets the lion's share of any benefit derived from them. G. H. HART.

Thompsonville, Conn.

Over-Fusing Dangerous

I was a spectator of an incident that prompts me to advise engineers not to meddle beyond the entrance switch of power lines. This switch may be opened or closed at will, but the fuse at this point should conform with the Underwriters' regulations and never be doctored to increase the carrying capacity.

A flour mill was being started in a small town, and its owner purchased a 15-hp. motor of the squirrel-cage type, to operate on the three-phase 220-volt supply. This motor was installed by the electric company furnishing it. It was a large machine for its rating, proving that it was an old timer.

Some fault appeared with the installation, as the fuses were continually blowing out. For several weeks men were sent to locate the trouble, each leaving the motor circuit with a larger fuse than he found on it. One fellow, having had nine years' motor experience, traced through the windings and inspected the starter, but found nothing wrong. Next, the service fuses were fixed up to carry more current.

As a last resort, unknown to the power company, the transformer fuses on the pole were raised in capacity. When the transformer burned out, the electricians realized there was something wrong with the motor and an expert was called to test it. It was found that the windings were very low in resistance, hence the large current drawn. The motor was diagnosed as a two-phase machine reconnected for three-phase. Replacing the motor with another one was the remedy advised, although it could have been rewound.

The lighting company put up a new transformer and, after some difficulty, collected from the contractor whose men had done the damage. One of the 120-ampere fuses with two No. 14 wires soldered across the ferrules, which had been used in the service cutout, was presented in court as evidence.

Baldwinsville, N. Y. ANTHONY J. CHRISTOPHER.

Comments from Readers

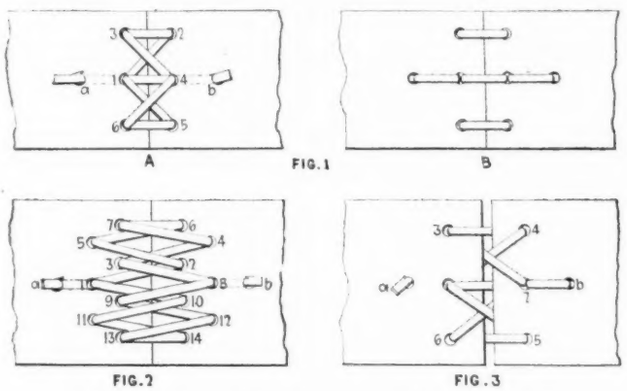
Pointers on Lacing Leather Belts

In the Nov. 9 issue there is an article entitled "Pointers on Lacing Leather Belts," which is good in the main, but I think a few "pointers" in addition thereto would be helpful.

In the first place, making all the tie holes on one edge of the belt is one thing that I have tried to avoid for years, because in time it will cause the belt to stretch on that edge and run lopsided.

In the wider belts more lacing is necessary than is furnished by a single row of holes. I would use two and often three rows of holes, as in Fig. 2 of the accompanying illustration. With the tie strings in the center the tendency is for the belt to stretch in the center which does no serious harm.

Where a belt passes over and around a number of pulleys, using both sides of the belt for traction and



Three types of laced splices for leather belts

perhaps a twist or two included, a still different type of laced splice is necessary. This type is shown in Fig. 3. It is what I would call a hinge or shoestring splice. Its one big advantage is flexibility, while its disadvantage is the wear in the crosses.

In Fig. 1 at *A* is shown the back of a belt as I would lace it, and at *B* is the front or pulley side. Holes *a* and *b* on the belts are the tie holes. As many of these may be made as thought necessary, although I have found one sufficient when a barb is made on the lacing.

The lacing is done by drawing the whang down through *a* (Fig. 1-*A*) up through 1, cross over and down through 2, up through 3, back down through 2, and back up through 3, cross over and down through 4, up through 1, straight over and down through 4 and up through 1. The last half is now done in the same manner and finishes by coming up through the tie hole *b* and cutting a barb, thus finishing a splice that is good on all belts up to 4 or 5 in. wide.

For belts wider than this the type of splice shown in Fig. 2 should be made. Only the back is shown, as the front looks very similar to *B*, Fig. 1. By a careful study of the illustration it can be determined how the holes are punched and laced, starting in at tie hole *a* and ending at tie hole *b*. A good rule to follow in punching the holes is one for every inch in width plus one if of an even width belt, and two if odd. Thus a 6-in. belt would have 6 + 1 or 7 holes, while a 7-in. belt would require 7 + 2 or 9 holes. There must be an odd number of holes, excepting the tie holes, or the lacing will not finish up right.

In Fig. 3 is shown a hinge splice. It will be noted that the finishing up is on opposite sides of the belt, that part of the strands are at an angle to the line of travel, and that the holes are punched in the same order as on other splices. This kind of a splice is used only where the belt passes over a number of pulleys using both sides of the belt for traction. For clearness the figure shows a single-row, single-laced splice.

The lacing is done in practically the same manner as for the other splices, except that the whang passes through a gap left between the ends of the belt and up through the proper hole on the other side. For lacing with two or more rows of holes the same general directions are to be used as given for other splices, except that the whang is to go through the gap in the belt before going through the next hole.

A laced splice is intended only for moderate powers and should be used only on large belts as an emergency measure. The commercial splices are superior to any whang splice, and there are a number of good splices on the market. Better still is a judicious use of the glue-pot on leather belts.

KENNETH R. GIDDINGS.

Billings, Mont.

Loyalty in the Power Plant

I read with considerable interest the Foreword in the Oct. 19 issue on "Loyalty" and am heartily in accord with the views expressed therein.

We hear a great deal about the desirability of employees having enthusiasm for their work in power plants and displaying loyalty to their employers. Enthusiasm and loyalty are the necessary prerequisites of efficiency. Unless a man feels enough interest in his work to be enthusiastic about it, he will value his job only for its material advantage to himself, and his feeling of loyalty to the interest of his employer will usually be a minus quantity.

To create this feeling of enthusiasm and loyalty in the power plant, the position of the chief engineer must be made worth while. It must be made a preferred job, one that men in the lower posts will strive to attain, not alone for its material rewards, but for the position and importance that go with it.

To be in a position to demonstrate to the men his good intentions, the chief engineer must mingle freely with the operators and engineers of the lower grades. Only in this way can he keep in close touch with the operations of his plant. He should invite suggestions and act on them if they are of value; listen to grievances and take steps to correct them when they are just, no matter how trivial they may seem—they may look big to the other fellow.

The chief engineer can be correctly judged only by general results and by these in relation to his resources. His general standing with his men and the public is always a good index to his character. His every act is closely watched and analyzed. The interpretations thus placed on his motives make up the general sentiment that fixes his standing with his men and consequently justifies or condemns his discipline.

The eminently successful chief engineer, therefore, is the one who is not only working for today, but has the prescience to see what the harvest will be tomorrow. His every act, in any way connected with the handling of men, is predicated on promoting confidence, the harmonizing of the countless differences and temperaments in the rank and file, to the end that a new synthesis may be formed—unity out of diversity, true *esprit de corps*. Loyalty and its offspring, discipline, are not forthcoming on a few strokes of the pen; they are growths, and the all-round, well-poised man is absolutely essential in the modern power plant for the desired results.

E. ANDREWS.

Manchester, England.

Why Not Assembly Drawings Instead of Models?

Having noted the reference in the Nov. 23 issue to the use of a model when planning the arrangement of pping, I re-read the article on modeling in the issue of Feb. 23 and, with past experience in mind, attempted to visualize the process as a part of the system for producing the drawings for a large central station under the usual conditions. I concluded that a radical change in conditions would be necessary to insure its successful application.

Consider a force of engineers and draftsmen, built up in a short period from a mere nucleus, to a hundred or more members working under the direction of executives constantly calling for speed to meet the demands of a construction force already in the field. It seems doubtful if a model department could keep up with the output of drawings, however well organized or skilled.

While heartily approving the use of models, I believe that fully as satisfactory results can be obtained by making large-scale assemblies from the detail drawings, making it a rule never to draw a line for which there is no dimensional authority. If the rule is adhered to, no better method for checking can be devised, for interferences are immediately obvious, provided the draftsmen assigned to these drawings are reasonably competent. If some one with operating experience is assigned to study the layouts as they progress, there should be little necessity for field changes.

It would seem that, to make either models or assemblies effective, there must be a reversion to an old theory, now given little attention. This theory is that the equipment of a station should be laid out first and the structure built around it, as best suits the conditions. In practice, the layout of the structure is determined with reference to a few major items of equipment and thrown into place with little regard for the others; the designers have to do the best they can with the space available, many a poor layout, from the operating point of view, being a credit to the ingenuity of the man who made it possible in any form.

Either models or assembly drawings will have limitations when used in connection with projects where speed, and hence a large crew of draftsmen, is the main consideration. They will be most useful to the engineering department of a public service corporation if called upon to design a new station, for in such a case the needs of the service can be forecast sufficiently to allow proper time for a complete design before beginning construction. The assemblies in this case would have the advantage that if made first as design drawings, those for pipe fabrication could be taken from them as single line layouts with corresponding savings in time.

So long as the usual construction program for large power plants calls for completion in from six to twelve months, so long will the drawings be produced under conditions fatal to accuracy; the slogan is more likely to be "Take a chance," rather than "Take enough time." Overhead, covering expensive corrections of design in the field, will be a necessary evil. If the model does away with all except minor changes and at the same time can be fabricated fast enough to meet the conditions of high speed elsewhere, a broad step will have been taken in engineering methods.

Providence, R. I. C. M. DURGIN.

A Pumping Problem Corrected

In the Sept. 21 issue a reply is made to an inquiry as to the effect of speed increase on the performance of centrifugal pumps.

This answer was somewhat confusing, for while the method of interpolation for speed increase was correct, the assumed conditions used for the example were based on an impossible power requirement for such conditions.

The inquirer stated that his pump, when operating at 200 r.p.m., required 100 hp., while the example used in the answer assumed a pumping condition of 5,000 gal. per min. against 100 ft. total head, which represents work equivalent to 126.3 theoretical horsepower.

The mistake, of course, in the first place was in not assuming a pumping condition that corresponded with the inquirer's power specifications, and incidentally one that was somewhere near a normal condition for the combination of power and speed indicated.

A centrifugal pump delivering 5,000 gal. per min. against 100 ft. total head, at 200 r.p.m. would be a pump with, say, a 12-in. discharge opening and an impeller approximately 100 in. in diameter. This would be somewhat of a monstrosity in centrifugal pump design.

The combination of 100 hp. and 200 r.p.m. suggests a pump of rather large capacity and low head.

For example, 25,000 gal. per min. 12 ft. total head, at 76 per cent efficiency, would represent about 100 b.hp. This would usually be a pump with, say, 30-in. discharge opening and impeller approximately 48 in. in diameter for 200 r.p.m.

The interpolation for this pump to a speed of 250 r.p.m. worked out in the same manner as described, and assuming that the efficiency also carried on at 76 per cent, would be as follows: Capacity, 31,300 gal. per min.; head, 18.6 ft.; and power, 195.5 b.hp.

So far as it appears, there was no request for information as to any method of limiting the capacity of the pump at the increased speed, and usually, when speeds are varied for any reason, the pump is permitted to adjust itself to the natural point on its characteristic corresponding with such speed variation without resorting to artificial methods.

Every pump has a natural constant-speed characteristic which may be influenced by the piping system in which it is installed, and it is impossible to determine where the readjustment of capacity and head at increased or decreased speed will take place, without definite knowledge of such characteristic at some speed approximating the desired operating speed and also of the pipe-line influence, particularly that of the suction line. This refers particularly to adjustments of conditions where close results are required.

It was stated that on account of the friction not increasing sufficiently to utilize all the total head shown by interpolation, a gate valve must be placed in the discharge pipe, which, by throttling, will increase the frictional resistance to the equivalent of 156 ft. total head.

This would mean throttling to produce an artificial friction head of 42 ft., or about 37 per cent of what should be the normal total head of 114 feet.

This seems to be a very wasteful method to suggest to the pump owner, that he should waste 37 per cent more power than is required to accomplish the necessary work.

Unless the new condition is only very temporary and it is essential in changing speed to step to a definite point beyond that actually required for the capacity wanted, it would be much better to change the impeller, either its diameter or otherwise, and operate the pump under most economical conditions.

E. F. Doty, Engineering Dept.,
N. Tonawanda, N. Y. Buffalo Steam Pump Co.

Lack of Efficiency in Engineering Schools

Reference is made to a letter from J. A. L. Waddell in the Oct. 5 issue. I was impressed that any engineer had the courage to speak out as boldly as Dr. Waddell has. The general inclination is to fear to tell the actual facts. Although I agree with most of Dr. Waddell's statements, I am confident that engineering schools are making a sincere and diligent effort to give the men practical information of value to them in later life. It is not, to be sure, entirely the fault of present-day professors that the system of today is as it is, but on the contrary they have come upon the scene with the system established.

When Dr. Waddell stated that it was not feasible, simultaneously to take notes and at the same time listen, he could have well said that it was so hard to do, that the main body of the class does not get enough notes to be of any practical value later on, but merely enough to enable them to pass the college examinations. This would have allowed some leeway for those students who have learned shorthand.

Any discussion of this subject, to have proper value, must contain some of one's own personal experience. The following is mine. In 1918, I was graduated at the head of a class of about twenty seniors in electrical engineering. The final work of the session was using the well-known hyperbolic functions and complex quantity, in connection with transmission-line calculations. So thorough had the lecturer's method been taken down that not only was 99 per cent received on the final work—done at home—but also, later on, while working for a public utility company and under a graduate of the same school, I found that my notes and his were so nearly alike that one could hardly see any difference except for the handwriting. In other words, for the years 1915 to 1918 the professor in charge had been giving exactly the same subject matter—at least from appearances. In this case he should not be censured, because the particular subject is one which must be learned today in most scientific schools. I would suggest that professors should be required to offer students copies of their lecture notes and base the examinations thereon.

There is one point that has not been touched upon, and that is what I should call the almost foolhardy practice in certain Eastern colleges of "putting the students on a competitive basis." That is, a certain number of problems are given out and the number of those questions which will be used as a basis for grades will be determined by the number of problems worked by "the best student." This is undoubtedly due to the effect of foreign methods upon our schools and the influence of manufacturing companies upon the college faculties.

While in many cases it may be best for a student not to forego pleasures to get through in three years, I can assure him that, regardless of what Dr. Waddell's decision would be in choosing between a man who had remained four years and one who had taken summer school (and in this case night classes) in order to go through in three years, some of the prominent companies have honored the writer—one of the latter class—by employing him very agreeably, indeed.

New York City. W. B. West.

In a recent letter on this subject C. O. Sandstrom refers to an engineer graduate having 12 to 14 years' experience and earning $175 a month, quite a usual result. In my opinion that is due to two reasons: First, the courses of studies do not supply sufficient information on any one subject to be effective; second, what is absorbed is too general to be of any special value. You cannot do much with anyone who has been taught to feel that he is educated to the point where he believes he is a superior type. In that respect he is of less value than one who does not pretend to know but is willing and has the ambition to learn.

To illustrate my point, where manufacturing methods are such that close limits are indicated, anyone who has no judgment will be of more value when properly instructed than an expert machinist who may resort to practices that have been considered by him as "near enough."

I believe Mr. Sandstrom will admit that point as to the value of a properly instructed specialist with little education as against another who feels that he is superior to any instructor who has been trained by actual experience doing actual and definite work.

It seems to me that about all that may be expected from a course of training to qualify for a degree is to supply the rudiments of engineering. The art of doing things is possible only after years of actual experience, and to be a successful engineer means more than a study of theories and principles together with a general smattering on many subjects of little real value.

I believe the value of technical training to be essential, but that it should be studied after a period of practical work. The results would be that what is found lacking would be recognized and absorbed; as it is, there is little chance to discriminate and less to recognize the real values that are essential to success.

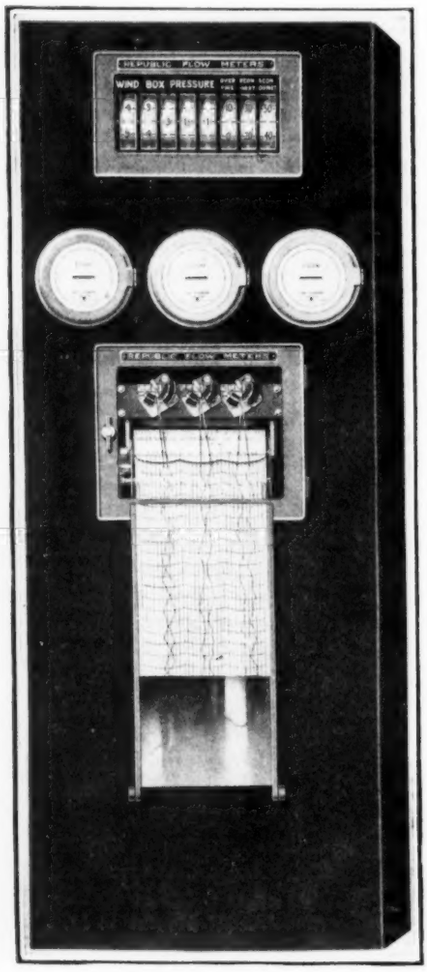
Cleveland, Ohio. James M. McIntosh.

New and Improved Equipment

Boiler Meter Panel

A new boiler meter panel brought out by the Republic Flow Meters Co., contains a graphic boiler meter in which provision has been made for six electric recording elements exactly the same as have been used in the company's flow-meter recorders. These elements record on one 12-in. chart of the strip type which affords uniform time values at all points of the scale and permits ready comparison of records, since the time arc maintains the same position relative to the eye. The chart is driven by an electric clock at a normal rate of travel of one inch per hour. The entire day's record is visible at all times, giving one shift the opportunity to compare results with another.

From the illustration it will be seen that the boiler meter chart is divided into three zones, giving, in effect, three distinct charts, all synchronized and having the advantage of continuous juxtaposition for ready comparison. In each zone it has been found almost impossible to combine more than two records without endangering the value of the records through interweaving.



Republic Boiler Meter Panel

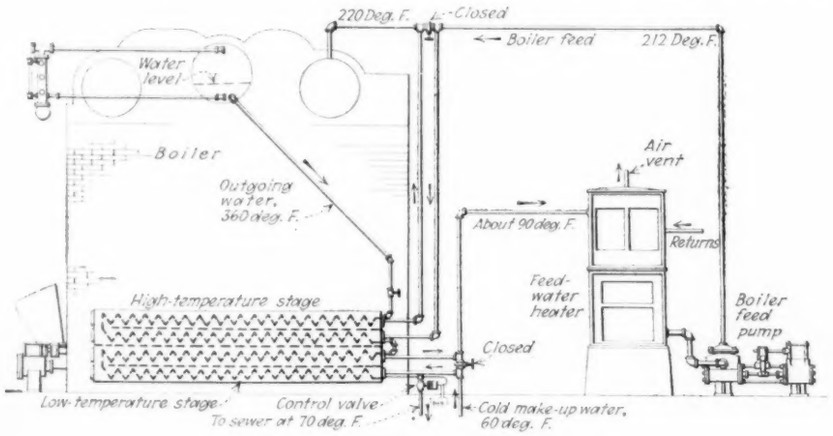
In the operation of any boiler, there are two factors of paramount importance, such as the rate of heat absorption, or the work done by the boiler, and the rate of heat loss. The steam-flow graph is a positive record of the heat absorption. Although the heat loss in the boiler is really a combination of various losses, it so happens that the stack loss is the major item subject to the widest variation, so that a record of the CO_2 content and the temperature of the waste gases may be taken as a satisfactory operating index of the total boiler losses and of the boiler efficiency. Therefore, both the CO_2 and the stack temperature are charted so that the two records may be observed simultaneously and in conjunction with the steam flow.

Besides these three records the choice of auxiliary records desirable will be determined by the character of the steam generating equipment. If economizers are used, the flue-gas temperatures entering and leaving are useful, as well as the water temperature leaving the economizer. With air preheaters a knowledge of the temperature of the inlet and outlet air is necessary in working out the boiler-room heat balance.

In addition to the graphic records outlined for the boiler meter chart, there are certain conditions of operation, such as drafts, best shown by an indicating instrument. These instruments are all embodied in one case, known as the Republic draft indicator which, with the integrating instruments necessary for the calculation and logging of results, is mounted along with the graphic boiler meter, so that the one panel affords a complete survey of the boiler operation.

The Henszey De-Concentrator

Drawing off concentrated impure water from the boiler and substituting fresh feed water, to which the heat of the blowoff has been transferred, is the function of the Henszey de-concentrator, made by the Rock Engineering Co., 620 Wells Bldg., Milwaukee. Keeping down the concentration by eliminating the soluble or suspended impurities, removes the cause of priming, foaming, scale and caustic embrittlement, with practically no loss of heat, and results in a clean boiler, clean water and clean steam.



How the De-Concentrator Operates

As indicated in the illustration, the de-concentrator has two stages, a high-temperature stage and a low-temperature stage, each consisting of two or more shells containing a nest of small tubes. As the troublesome impurities are more concentrated at the boiling surface in the steam drum than elsewhere, the impure water outlet pipe to the de-concentrator is connected to the steam drum on a level with the bottom of the gage glass, this location of the outlet making it impossible to drain the boiler through the pipe.

The usual feed-water line is allowed to remain in use as before, except that it is cut and two tees with a closed valve between them are installed to provide a bypass connection to the high-temperature stage of the de-concentrator. The cold-water makeup line to the feed-water heater is likewise cut and two tees and a closed valve installed, providing a bypass connection to the low-temperature stage of the de-concentrator. If there are any hot-water returns, they are fed to the heater without any change.

Reference to the drawing will show that the impure water is withdrawn from the boiler near the steaming sur-

face and flows through a small pipe to the de-concentrator, passing through the nest of tubes in the high-temperature stage, where it is cooled by the incoming boiler-feed water from, say, 350 to about 212 deg. F. The flow continues into the low-temperature stage, where the outgoing blowoff water is cooled by the incoming makeup water from about 212 deg. to a lower temperature, say 65 deg., at which a control valve is set and will pass it at this temperature to the sewer. A meter is installed at this point to show how much water is being exchanged.

Tracing the piping, it will be seen that the cold makeup water passes to the low-temperature stage, where it receives a preliminary heating from the outgoing boiler water. Admission from this stage to the heater is regulated by the usual heater control valve.

From the feed-water heater all the boiler feed passes through the high-temperature stage of the de-concentrator, picking up some heat in the process although the rise in temperature is small owing to the much greater quantity of ingoing water. With this equipment automatic controls have been tried with success, blowing off according to temperature, rate of flow of makeup, degree of concentration, etc.

Deconcentration can be carried to any extent desired, but experience has shown that an exchange of 5 per cent of the water fed to the boiler generally will produce the desired results. On the foregoing basis the cost of deconcentrating has been placed at 2 cents per day for each 1,000 sq.ft. of boiler-heating surface.

Arco Motor Valve

A series of high-pressure, motor-operated valves in sizes ranging from ½- to 2½-in., arranged for manual remote control through a two-circuit hand-operated switch or for automatic full-voltage control, with diversified applications for temperature, pressure

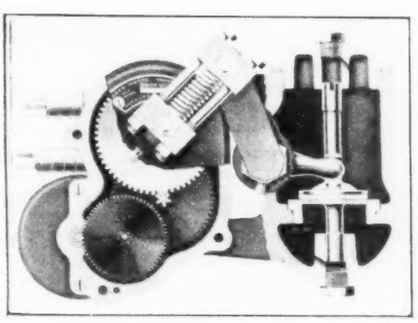


Fig. 1—Valve and motor unit

and vacuum, has been put out by the American Radiator Co., Chicago, Ill. Wherever a valve is to be opened or closed according to temperature or pressure changes, the new type of valve has its uses. Typical examples for pressure or vacuum control are pressure and vacuum pumps, water-level control, steam-operated compressors, barometric condensers, etc.

Fig. 1 shows a section through the valve and its connection with the motor through a reducing gear having a ratio of 1,100 to 1. With ample power it has been possible to use a single-seated valve, which has its advantages from the viewpoint of wiredrawing and in the grinding of the valve to maintain a true seat.

For the speed reduction two composition and one steel gear and steel pinions are mounted in a tight cast-iron casing filled with gear compound. No refilling or oiling is required. The motor is of the universal type for 110 volts, drawing 0.3 ampere during the closing or opening operation, which takes approximately eight seconds.

In operation the Mercoid control makes electric contact with either an increase or decrease of pressure or temperature, which causes the main gear shaft of the motor valve to make a half-revolution, closing the valve. Contact on the opposite side of the control causes the shaft to make another half-revolution, opening the valve. At the end of each half-revolution the circuit is broken by means of a rotary snap switch mounted on the main gear

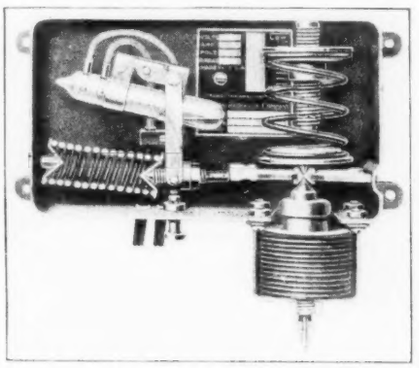


Fig. 2—Industrial-type control

shaft. Thus the valve is either tight closed or wide open. By special wiring connections the valve can be installed either to open or close with advancing temperature or pressure.

Fig. 2 shows a control of the industrial type that will carry motors drawing 10 amperes at 110 volts or less. Motors drawing more current are controlled through the use of a relay switch.

In operation the power element, consisting of a seamless, metallic bellows, is expanded automatically by the temperature or pressure against the action of a spiral spring, the compression of which may be changed by screwing up or down on the spring cap.

The force created by the bellows is transmitted to the tilting mechanism of the switch and throws the latter with a snap action. With a decline in pressure or temperature the spring returns the switch to the normal position. A second spring pivoted between point bearings, pushes against the tilting mechanism. By an adjusting screw it is possible to change the compression of this spring and thus vary the operating differential after the controller has been installed. When used thermostatically, the bellows is filled with liquids of various boiling points, as determined by the desired operating temperature range.

For temperature control on domestic oil-burning equipment, refrigeration and general industrial work, Mercoid thermostats of the single- and double-circuit types have been developed. A typical industrial application is the control of unit heaters in manufacturing plants, the temperature being controlled

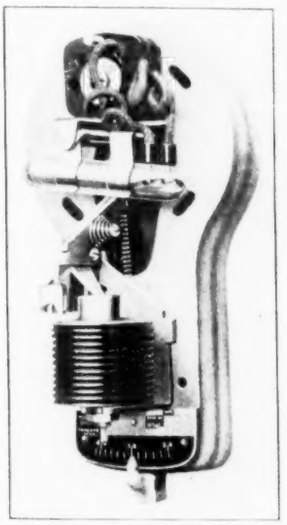


Fig. 3—Mercoid thermostat of the single-pole, single-circuit type

according to the work that is being done.

As in the case of the other controller the operation of the switch is effected by a bellows containing a volatile gas which expands with an increase in temperature and, in conjunction with a compensating spring, causes the control to move with a quick snap action. These thermostats, as well as the industrial control previously described, can be equipped with flexible tube and bulb connection to the bellows for the control of liquids or with direct bulb connection for insertion in tanks or pipe lines.

Soapless Grease

To A. L. Nugey, New York City, is attributed the discovery and subsequent development of a soapless lubricating grease, which differs from the ordinary grease in that it possesses an exceptionally high lubricating value, and in addition creates a new outlet for many low-grade oil-refinery products and displaces the further use of expensive animal fats and alkalies as generally employed.

In general all greases are composed of mineral oils and soap, the soap content being a saponification of such fats as tallow, lard, oil, etc., which is produced by the aid of alkalies such as soda, lime, etc. These fatty ingredients, which form the soap properties in greases, contain little if any lubricating qualities and merely act as the carriers of the mineral oils.

It is claimed that in the new grease, through the introduction of certain ingredients, the ordinary fats are replaced advantageously by physical reaction.

A Noteworthy British Turbine

Engineering (London) for Oct. 15, describes a turbo-generator recently installed at the Valley Road Power Station of the Bradford Corporation. This is a 20,000-kw. tandem unit running at 3,000 r.p.m., built by the English Electric Co., Ltd., Willans Works, Rugby, England. It is believed to set a new record of high output combined with high speed.

Tests under the direction of W. M. Selvey were made with special care in checking and calibrating instruments before and after the test, and the results have been very gratifying. With steam supplied at a pressure of 190 lb. per sq.in. gage, with a temperature of 659 deg. F. and with 2 in. of mercury absolute exhaust pressure (the station using cooling towers), the steam rate for 12,000-kw. load is 11.43, for 16,000 kw., 10.95, and for 20,000-kw. load, 11.00 lb. The engine efficiency attained 81 per cent, which is among the highest yet recorded. At 18,000 kw. the thermal efficiency was 26.1 per cent, and when steam was bled from the turbine for feed heating purposes, the thermal efficiency reached 27.78 per cent.

The turbine is a two-cylinder machine, the high-pressure section, which develops 60 per cent of the total output, being constructed on the impulse system, while the low-pressure turbine is a double-flow reaction machine. The impulse section has twelve stages, and is designed for comparatively low steam velocities, since recent investigations indicate that this is conducive to higher efficiency.

The Rotor Forgings

The high-pressure rotor is a single forging, the wheels being machined out of the solid. This shortens the shaft and raises the critical speed well above the running speed. The absence of wheel hubs reduces the diameter of the diaphragm packing to only 10¼ in., and thus reduces diaphragm leakage to about one quarter of 1 per cent. The small diameter of the rotor, and the fact that admission is around the entire periphery, reduces the disk friction to the small value of about two-tenths of one per cent.

Rotor forgings were drilled with a 3-in. diameter hole along the axis for inspection and testing. The running blades are milled from nickel steel, and the shrouding is edged with a thin copper strip. Means are provided for adjusting the axial position of the rotor through movement of the thrust bearing so that these end tightening strips may be adjusted properly when the machine is erected.

The drum-type rotor of the low-pressure turbine is machined from a solid forging. The blades are rolled from mild steel, with the exception of those for the last stage, which are milled from solid metal. The last row of blading provides 31 sq.ft. of steam area, and at 2 in. absolute exhaust pressure and full load the leaving loss amounts to only 1.14 per cent of the adiabatic heat drop.

The governor, fitted with ball bearings throughout, is arranged to provide a variation of 16 per cent of the turbine speed. This long travel is utilized to provide means for adjusting speed in synchronizing without the use of an external spring, which involves an additional and variable load on the governor bearing. Adjustment is had through a motor-driven nut operating a threaded sleeve which carries one end of the floating lever of the governor mechanism.

All valve casings are steel castings, and the overload valve is machined from a solid forging, which is more homogeneous and less liable to distortion than a casting. Care has been taken to make all castings of simple form so as to reduce the possibility or risk of porosity.

Does the Color of Oil Mean Anything?

Some engineers set great store by the color of oil but refining experts claim that color in itself means nothing, except as a trade-mark or a style. The following paragraphs from "Oil Power," published by the Standard Oil Company of New York, explains the refiners' attitude in this matter.

Some customers think that color is the value they are buying when, as a matter of fact, colors can be duplicated or blooms can be changed without in any way affecting the lubricating value of the oils. It is becoming a recognized fact that while color is an interesting characteristic of an oil, it is not of itself of great value except as a means of identification.

However, color may be some slight indication of the value of a lubricating oil if the oils under consideration are made by the same refiner and by the same system from identical crudes. In such case a run of oil may have poor color, due to some greater than usual decomposition that may occur during refining. As a rule, however, but little reason exists for any claim that the darker oils will give more lubrication than the lighter oils. Color is merely a matter of refining method. Either dark or light oils may be distilled from the same crude. In finishing it is possible to give a normally light oil a dark color or vice versa.

Color likes and dislikes change with the years; they might be termed the styles in oils. Sometimes oil is dressed in red, sometimes in yellow, sometimes the bloom may be green and yet years later it may be brown; and throughout all these color changes the true qualities of the oil that affect its intrinsic value as a lubricant remain the same or may even be improved. Color, then, is an identification mark only. It can be duplicated. Manufacturing methods in the oil business do not always remain the same. When such methods change so that an oil is naturally made light in color, trade demands may require that it be darkened to satisfy a peculiar whim of a purchaser who previously knew this oil as dark.

All oils in use constantly change in color. This is due either to the effect of oxygen which causes a red tinge, to water which turns the oil gray, or to iron which turns the oil dark. In bearings subjected to high temperature and in internal-combustion engines the oil will also slowly turn black due to charring or to actual burning. In this case the odor of the oil is termed "burned." Any carbon in the underside top of the piston of an automotive engine will contain enough burned oil to color several quarts of light pale oil to a dark red. It takes but very little coloring matter to affect oil. When light-colored oils are used a short time in the crankcase of a gas engine, they invariably turn dark, if not black. These oils can be cleansed of this foreign coloring matter and filtered back to their original bright color, which demonstrates that the true body of the oil is not affected by the coloring matter.

Assessing Damages Once for All

By Arthur L. H. Street

Where the nature of a power plant is such that injury to near-by property through operation of the plant will necessarily be a continuing one, the owner of that property will not be permitted to bring successive suits for damage. He must seek recovery in one suit for past and prospective damage. And failure to bring the suit within the time allowed by local statute forever debars the property owner to sue. This is the meat of the decision handed down by the Oklahoma Supreme Court in the case of Consumers' Light & Power Co. vs. Holland, 247 Pacific Reporter, 50.

The power company constructed a spray pond as a part of its plant for generating electric current in 1918. It was not until 1923 that a property owner sued for damages caused by spray and vapors blown upon his property from this plant. The Supreme Court decided that the delay in suing was fatal to the claim. The court said, in part:

"It is not disputed that in the generation of electric current by means of a turbine engine it is necessary to continually cool the water pumped from the engine by spraying the same into the air, and that in no other way could the pond be operated so as to cool the water sufficiently to keep the steam turbine in operation.

"It is likewise undisputed that the use of a turbine engine and spray pond is the most economical method known for the generation of electric current. Therefore the injuries of which the plaintiff complains . . . were obviously certain to occur with the continuance or recurrence of ordinary conditions. . . .

"While it is true there is some evidence that the defendant might have used a different type of machinery for the generation of electric current, less economical in its operation, it is not contended that its failure so to do under the circumstances amounted to negligence. . . .

"Whether the injuries which plaintiff might sustain were in the nature of personal annoyance and inconvenience while in the lawful occupation of his property, or in the nature of a physical injury to the property itself, they were obviously certain to occur and equally capable of estimation at the time of the erection of the improvement, and were all recoverable in one action at the time the defendant constructed and began to operate the spray pond."

News in the Field of Power

Governor Smith Urges Plan To Put Power Resources Under Control of State

Wants a Body Like That Supervising the Port of New York—Believes It Could Finance Itself Without Loss—Owen D. Young Endorses Policy as Outlined

GOVERNOR SMITH outlined his plan for a power authority to develop the state water-power resources Dec. 13 in a speech before about 800 persons at a dinner of the Survey Associates, Inc., publishers of *The Survey* and *The Survey Graphic*, at the Hotel Astor.

He proposed that the power authority be created by the Legislature as an instrument of the state, like the Authority of the Port of New York, with the power to finance itself by issuing bonds against earning power, and to make contracts with private companies for the distribution of power.

The question whether such a power authority would be able to produce and distribute power at a price that would make possible its operation without loss, he declared, he was willing to submit in advance to a group of non-partisan power experts.

Opposes All Power Leases

Governor Smith heatedly denied charges that his program was socialistic, and asserted that the theory of state ownership and state control of water-power development originated not with himself, but with former Governor Charles E. Hughes.

The fundamental principle of his program, the Governor said, was that the water power of the St. Lawrence and Niagara Rivers was the property of the state and should not be alienated even by lease for any period of time.

The Governor did not give as many details of his plan as had been expected, but devoted the larger part of his address to arguments in support of his general water-power policy and in opposition to the present method of dealing with the water-power problem.

He argued that it was a business and not a political matter, charged that the members of the present Water Power Commission knew nothing about water power, and admitted that the make-up of the new commission, which will have power after Jan. 1, will be even worse because it will not include the state engineer in its membership. He emphasized that the state now has no properly equipped agency for the study of water-power possibilities.

Finds Ally in Young

A cautious and guarded ally in the Governor's plan is Owen D. Young, chairman of the Board of Directors of the General Electric Co.

But although Mr. Young agreed it might be feasible for a public corporation, similar to the Authority of the Port of New York to undertake the development of power derived from the St. Lawrence and Niagara Rivers, he strongly objected to the phase of Governor Smith's proposal that the state itself should invest any capital in the enterprise.

"In so far as Governor Smith's plan contemplates the use of private capital supplied to a public corporation for the development of the St. Lawrence, I am in agreement with him," said Mr. Young. "He is quite right in saying this will provide the normal economic check on an unsound enterprise.

Opposes State Aid

"At one point in his speech, however, he suggested the state itself might put in a little money if it were needed and the taxpayers would not know the difference. At that point I am in complete disagreement with him as a matter of principle. The moment the state begins to contribute money from the public treasury the economic check on the enterprise is lost. Such contributions always begin by being little ones. They always end by being big ones under the excuse of saving what is already in.

"The principal practical difficulty in the Governor's program is that the entire cost of the enterprise must be financed by bonds. In order to do this there must be a margin or guarantee funds for the bonds or investors will not take them. In the case of a private corporation probably not more than 60 per cent of the cost would come from bonds, the remainder would be provided by stock, and this stock would form the guarantee fund. It may be practicable to have the public corporation contract with private power companies for the power output at such a price as well be sufficient to pay the interest and sinking fund on the bonds. If so such contracts will have to be made before the bonds are sold, and will have to be for a term long enough to insure the safety of the bonds.

Freedom from Coal Troubles

"The Governor is quite right in saying the bonds can be made additionally attractive by tax exemptions. They could be made even more attractive by making the physical property of the corporation also tax exempt.

"I never have believed power could be had from the St. Lawrence so much cheaper than coal as to enable great savings or great profits to be made out of it. But if it can be done as cheaply as coal, New York State will have control of her own basic power supply. A strike in the coal mines, taxes on coal exports by coal-producing states and interruption of transportation all menace our power supply. If we harness this great river we shall control our own."

Questions Involved

The Governor made it clear that the problems of engineering and finance could be met in the future as the water power study progresses. The immediate questions to be settled are those of public policy such as:

(1) Shall the state go into the power development business either directly or indirectly through a public corporation?

(2) Shall the state subsidize power development through tax exemption of securities issued for or of physical property engaged in power development?

(3) Shall public officials be substituted for private men in the construction of such enterprises?

"These questions can and should be settled now. If answered in the affirmative, then the Water Power Authority should be promptly created. The development of the river is the thing. As a matter of business let us get it done."

Georgia Power Utilities To Consolidate

Plans under which it is proposed that the Georgia Railway & Power Co. and the Georgia Railway & Electric Co. will be consolidated with four other Georgia power companies were submitted to a meeting of stockholders of the respective companies held in Atlanta, Ga., Dec. 15.

Companies to be consolidated under the proposed plan are the Georgia Railway & Power Co., Georgia Railway & Electric Co., Georgia Power Co., Athens Railway & Electric Co., Rome Railway & Light Co. and the East Georgia Power Co.

Directors of the six companies involved have approved the proposed consolidation, according to Preston S. Arkwright, president of the Georgia Railway & Power Co.

The proposed consolidation affords the vehicle for providing for a very large section of the state an adequate, dependable public utility service which would not be possible otherwise, according to Mr. Arkwright.

Plans for the exchange of stock of the old companies for stock of the new company and the basis on which the consolidated interests will operate have been the object of careful preparation and study.

Offers $17,500 in Prizes for Arc-Welding Essays

Awards totaling $17,500 will be made in 1928 for the best papers submitted on arc welding in a world competition, it was announced, Dec. 10, by Charles M. Schwab, new president of the American Society of Mechanical Engineers, following a meeting of the society's council at the close of the forty-seventh annual meteing.

The prizes are offered by J. F. Lincoln, vice-president of the Lincoln Electric Co., of Cleveland. The first prize is $10,000, the second $5,000 and the third $2,500. The society's council voted to act as custodian of the awards for next year.

The statement of Mr. Schwab, who presided at the meeting of the council yesterday, follows:

"The replacement of cast iron and riveted steel with arc-welded structural steel is probably the next great step forward to be taken by industry. It is self-evident that since steel is five times as strong and two and one-half times as rigid as cast iron, it is better metal than cast iron for all machine purposes.

Economic Advantage Enormous

"When it is considered that each pound of structural steel costs only one-third as much as cast iron, its economic advantage becomes self-evident. In order to obtain this great advantage of steel over cast iron much work must be done in design and in the application of arc welding. Part of this work already has been done with enormous economies, but much more remains.

"In order to stimulate active thought along this line and to encourage the growth of a new industrial process, the Lincoln Electric Co. is offering to the American Society of Mechanical Engineers the sum of $17,500 to be awarded for papers submitted on arc welding.

"Originality of design is preferable either in the method of applying the weld or in the design of the welding parts for their arrangement. Designs which are of no practical use will only be considered in case they include suggestions which could self-evidently be applied in other ways than those suggested.

Wide Use for Suggestions

"Attention is called to the fact that these prizes are offered with the sincere desire to promote the whole art of arc welding and to reduce the cost of carrying out mechanical designs. All authors of papers may be sure that their suggestions will find the widest use."

The papers in competition are to be supplied in duplicate to the council of the American Society of Mechanical Engineers, addressed to its secretary, Calvin W. Rice, 29 West 39th St., New York, before Jan. 1, 1928. One of the papers will be sent to the Lincoln Electric Co.

New Territory Is Opened by Tidewater Power Co.

The town of Atkinson, 20 miles northwest from Wilmington, N. C., heretofore served by small privately owned power plants, will be connected to the Tide Water Power Co. service under a franchise to operate in the town just secured by the company. A large number of customers between Wilmington and Atkinson also will be served.

H. M. Giles, Marine and Power Engineer, Dead

Harry M. Giles, well known in the marine and power industries and since 1919 general superintendent at the South Philadelphia plant of the Westinghouse Electric & Manufacturing Co., died at the Hotel Dennis, Atlantic City, N. J., Dec. 14, as the result of heart trouble.

Harry M. Giles

With Westinghouse Since 1900

Business associates and intimate friends, together with members of the immediate family, attended the funeral services Dec. 18, held in the Swarthmore Presbyterian Church, Swarthmore, Pa. Immediately after the ceremony the body was taken to Providence, Rhode Island, for interment.

Began With Corliss Company

Mr. Giles, who was 57, had been associated with the Westinghouse company since 1900. He was born in Boothbay, Me., March 23, 1869. Beginning his business career as testing engineer with the Corliss Steam Engine Co. of Providence, R. I., he left this company in 1886 to join the Calumet & Hecla Mining Co., in the capacity of chief engineer. He remained with this concern until he came to the Westinghouse company in 1900 as superintendent of the Corliss engine department. He later was promoted to marine superintendent, and in 1919 was transferred to the South Philadelphia plant, as general superintendent.

Prominent A.S.M.E. Man

Mr. Giles was a member of the American Society of Mechanical Engineers, Players Club, Foundrymen's Association, and was also a director of the Tinieum Bank of Essington.

William D. Coolidge Awarded Edison Medal for 1926

The Edison Medal for the year 1926 has been awarded by the Edison Medal Committee of the American Institute of Electrical Engineers to Dr. William D. Coolidge, for the origination of ductile tungsten and the fundamental improvement of the X-ray tube.

Founded by associates and friends of Thomas A. Edison, this medal is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," by a committee consisting of twenty-four members of the American Institute of Electrical Engineers.

The following men have been recipients of the medal: Elihu Thomson, 1909; Frank J. Sprague, 1910; George Westinghouse, 1911; William Stanley, 1912; Charles F. Brush, 1913; Alexander Graham Bell, 1914; Nikola Tesla, 1916; John J. Carty, 1917; Benjamin G. Lamme, 1918; W. L. R. Emmet, 1919; Michael I. Pupin, 1920; Cummings C. Chesney, 1921; Robert A. Millikan, 1922; John W. Lieb, 1923; John White Howell, 1924; Harris J. Ryan, 1925.

Doctor Coolidge, assistant director of the research laboratory of the General Electric Co., physical chemist, was born in Hudson, Mass., Oct. 23, 1873. A graduate of the Massachusetts Institute of Technology, B.S., 1896, and of the University of Leipzig, Ph.D., 1899, he became associated with the General Electric Co. in 1905 and assistant director of the research laboratory in 1908. He was awarded the Rumford medal in 1914 for invention and application of ductile tungsten.

Doctor Coolidge is a member of the American Chemical Society, American Electrochemical Society, American Physical Society, American Institute of Electrical Engineers, American Academy of Arts and Sciences and the Washington Academy of Sciences. He is an honorary member of the American Roentgen Ray Society, American Radium Society, Radiological Society of North America, Roentgen Society (of England), Societe de Radiologie Medicale, and the Nordick Forening for Medicinsk Radiologi.

Stone & Webster in Combine With Blodget & Co.

Stone & Webster, Inc. and Blodget & Co. have joined in the formation of a new company under the name of Stone & Webster and Blodget, Inc. The company will begin operations Jan. 1, 1927, with an authorized capital of $10,000,000.

The corporation is a combination of the securities department of Stone & Webster, Inc., and the old investment house of Blodget & Co. The engineering and construction, management, and investigating departments of Stone & Webster, Inc., are not included and will not be affected by the combination.

Bayard F. Pope, now a partner of Blodget & Co., will be president of the new corporation. Other officers and the directors will be drawn from both the participating companies, all the present partners of Blodget & Co. being officers of Stone & Webster and Blodget, Inc.

Exhibitors Vote Power Shows Success—Endorse Committee

On Friday morning of the week of the Power Show at New York a large number of the exhibitors met to discuss Power Show results and policies. The meeting was presided over by Irving E. Moultrop, chairman of the Advisory Board of the New York Power Show.

J. C. McQuiston, of the Westinghouse Electric & Manufacturing Co., and F. H. Gale, of the General Electric Co., presented discussions from the point of view of the exhibitors; excerpts were read by the chairman from letters from engineers who profited by attendance, and E. G. Bailey and Starr Barnum, respectively chairman and secretary of a committee that had collected information on the subject, reported that the four neighboring states furnished over 80 per cent of the attendance at both the New York and Chicago Shows, and that a large majority of the exhibitors who had responded to their questionnaire were pleased with the results at both New York and Chicago.

To Ballot on Future Plans

After considerable discussion as to the desirable frequency of future shows the meeting adopted the following motion: That the Exhibitors' Committee of the Power Shows, as now constituted, be instructed to take a vote by letter ballot of the exhibitors of the New York 1926 Power Show and the Chicago 1927 Power Show; that this ballot contain the following items:

(1) That the exhibitors approve the Committee as now existing and the suggested by-laws prepared by the Committee which will be attached thereto; (2) such other information to be contained in said ballot as they may see fit; (3) that exhibitors indorse the actions of the Committee, and agree to co-operate with it as far as possible. That the results of these ballots be submitted to the exhibitors after a reasonable number have been returned and tabulated.

During the week of the exhibition more than 100,000 inspected the displays, it is estimated.

Leipzig Trade Fair To Mark Industrial Reorganization

The Leipzig trade fair, representing every phase of the industrial life of Germany, will be held from March 6 to 12. The fair makes it possible to measure definitely the recent progress of German industries. It will include more than 12,000 exhibits, a gain of over 300 per cent over any pre-war fair.

The official announcement shows that substantial progress has been made along all industrial lines. More than 150,000 buyers from upwards of fifty countries will attend. The United States will be better represented both as exhibitor and buyer at this spring fair than ever before. The Leipzig Fair has been happily called the "Industrial League of Nations."

Germany's reputation for ingenuity and organization is justified by the fact that there will be included some 2,300 exhibits of machinery.

Midwest Power Sessions Plan Utilization Features

Plans for the second Midwest Power Conference, scheduled for the Coliseum in Chicago, Feb. 15 to 18, indicates that this year's sessions will be of unusual import to power engineers and managers throughout the country, remarking valuable contributions to power engineering progress.

The general program of the 1927 conference is designed to deal with the larger aspects of power utilization in the fields of industry. Five sessions have been outlined: The opening meeting Tuesday, Feb. 15; two industrial sessions on Feb. 16; the gas power conference the morning of Feb. 17, with the fuel session following in the afternoon. Opportunity will be afforded for the discussion of each paper contributed by well-known authorities on the foregoing general topics. Authors and titles will be listed on the release of the detailed program.

Friday Feb. 18 will be devoted to inspection trips to important plants in the Chicago territory. During the same week and in the same building Chicago will hold its second Midwestern Engineering and Power Exposition, officially known as the Chicago Power Show.

This conference is sponsored and indorsed by the local sections, regional and professional divisions of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, National Electric Light Association, Western Society of Engineers and the National Safety Council.

The officers of the conference are: William S. Monroe, president of Sargent & Lundy, chairman; G. E. Pfisterer, secretary, and C. C. Whittier, of Robert W. Hunt Co., treasurer.

Canadian Boiler Kills Five in Explosion

A boiler exploded, killed five employees of the Canadian National Railways, and wrecked the building in which it was located on Nov. 29 at Doucet, Province of Quebec, Canada.

Of the stationary type the boiler was used for power purposes and was owned and operated by the Canadian National Railways. It is understood that this boiler was insured by a Canadian company in the sum of $50,000, with $25,000 available for each person injured or killed. The amount of property damage has not yet been ascertained.

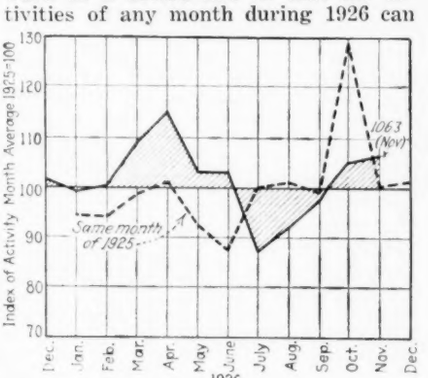
Ohio Northern Service Co. Acquires Franchise

The passage of the rate ordinance and franchise for electric power and light giving grant to the present Ohio Northern Public Service Co. went into effect recently. The ordinance was once passed but was later rescinded because the council was informed that another company would offer rates 25 per cent lower.

Activity in Boiler Industry Above Last Year

Power presents herewith a new barometer of activity in the boiler manufacturing plants of the nation. This barometer is based upon the electrical energy consumption of a large portion of the boiler manufacturers of the country, these manufacturers consuming approximately 53,300,000 kw.-hr. per annum. Electrical power enters into the actual productive activities of industry to such a large degree today that any reaction in the industrial life of the nation is immediately reflected in the demand for electric current. Based upon extensive study that has been given to the subject, it is believed that electrical energy consumption by manufacturing plants is one of the best barometers of industrial operations available today. This is particularly true of industries where large quantities of process steam do not enter into the problem. *Power* intends issuing several more of these barometers covering various types of specialized manufacture of power equipment.

In the accompanying barometer of operations in the boiler manufacturing plants of the country the actual monthly energy consumption is compared to the monthly average for 1925, the monthly average for 1925 being given a rating of 100. In November, for instance, the activities in the boiler manufacturing plants were 6.3 per cent above the monthly average of activity in 1925, and in August they were 8 per cent under the monthly average for 1925. No correction has been made for seasonal variation, the figures being a direct reflection of the energy consumption by reporting companies during the various months. The monthly index figures for 1925 have been carried forward as a dotted line so that the activities of any month during 1926 can



Showing Monthly Energy Consumption Compared with Monthly Average of 1925, Rated at 100

be compared directly with the activity of the same month last year.

During 1926 the boiler manufacturing plants have been operating on the whole considerably above last year; only during the summer and early fall months were operations under those of last year. Preliminary figures for November indicate that production activities during that month were about 6.3 per cent above November of last year.

These barometers will be issued monthly and reprints will be furnished to those interested upon application.

Interstate Power Co. Opens Operating Headquarters

The Interstate Power Co., controlling six light and power companies with numerous local properties in South and North Dakota, Minnesota, and Nebraska, has opened its operating office at 320 Security Bank Bldg., Sioux Falls, S. D., with Thomas Donohue in charge as divisional manager. The office previously was located at Minneapolis. The financial and account offices are at Dubuque, Iowa.

Properties controlled by the company are the Tri-State Utilities Co., the Minnesota Electric Distributing Co., the People's Light & Power Co., the Red River Valley Power Co., the Bemidji Electric Manufacturing Co., and the Interstate Public Service Co.

Matters in connection with the operation of numerous plants will be handled from the Sioux Falls office.

Buys Southern Engine Works With $52,000 Bid

A bid of $52,000 made by Fletcher Goodwill of Jamestown, Ky., for the plant of the Southern Engine & Boiler Works, Jackson, Tenn., has been accepted by the Marine Trust Co. of Buffalo, which sold the plant as trustee. The plant was placed in bankruptcy some weeks ago. The bid is understood to be over and above the taxes, which amount to approximately $30,000.

Personal Mention

A. H. Myers, engineer with Stone & Webster, Inc., is now representative for Stone & Webster, Inc., and located at 1179 National Ave., Milwaukee, Wis.

Wilfred S. Lowry started with the American Brown Boveri Electric Corp. Nov. 22 and is assigned to the blower division, Camden, N. J., as an application engineer. He is a graduate of Queens University in electrical engineering and has been with the General Electric Co. at Lynn, Mass., where he specialized on centrifugal compressors constant-current transformers and small turbines.

Dr. Ira Nelson Hollis, retired president of Worcester Polytechnic Institute and past-president of the American Society of Mechanical Engineers, was the recipient of a dinner in his honor tendered by the Engineers' Society of Milwaukee at the Milwaukee Athletic Club, Dec. 15. Contributing the principal address on the meeting's general topic of "Education for Engineering As a Profession," Doctor Hollis spoke on "The Influence of the Engineer."

Lloyd L. Smith, formerly in charge of the power department of the Morgan-Gerrish Co., announces that he is taking over the power accounts of that company Jan. 1, 1927, and will conduct this branch of the business under his own name at 605 Plymouth Bldg., Minneapolis, Minn. Mr. Smith will continue to represent several Eastern manufacturers, including Combustion Engineering Corp., R. H. Beaumont Co., M. H. Detrick Co., A. W. Cash Co. and Ruths Steam Accumulator Co.

J. M. Van Nieukerken recently joined the organization of the American Brown Boveri Electric Corp. as a railroad project engineer. Mr. Van Nieukerken is a graduate of Delft Technical University in electrical engineering and was previously connected with: General Electric Co., Ltd., Birmingham, England; British Westinghouse Electric & Manufacturing Co., Ltd., Manchester, England; Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., and the Cleveland Union Terminals Co., Cleveland, Ohio.

Coming Conventions

American Association for the Advancement of Science. Annual meeting at Philadelphia, Dec. 27-Jan. 1; Burton Livingston, Secretary, Smithsonian Institution Bldg., Washington, D. C.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting will be held at Montreal on Thursday, Jan. 27, and will be adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

Midwest Power Conference, at Chicago, Feb. 15-18. Sessions will be held in the Coliseum concurrently with the Chicago Power Show; G. E. Pfisterer, secretary.

National Association of Stationary Engineers. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Marine Engineers' Beneficial Association. Fifty-second annual convention at the Hotel Franklin Square, Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Society Affairs

The National Association of Stationary Engineers, of Trenton, N. J., are holding their annual banquet at the Hotel Sterling on Saturday evening, Jan. 8. R. Mason, 104 Parker Place, Trenton, N. J., is secretary of the banquet committee.

The Providence Engineering Society will hold the coming year's annual banquet at the Hotel Biltmore, Providence, R. I., Feb. 16.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Dec. 13 1926
Pool 1	New York	$3.75@$4.00
Smokeless	Boston	3.10
Clearfield	Boston	2.40@ 2.90
Somerset	Boston	2.50@ 3.10
Kanawha	Columbus	2.00@ 2.25
Hocking	Columbus	1.90@ 2.25
Pittsburgh	Pittsburgh	2.00@ 2.25
Pittsburgh gas slack	Pittsburgh	1.90@ 2.00
Franklin, Ill.	Chicago	2.75@ 3.00
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.50@ 2.75
West Ky.	Louisville	1.25@ 2.00
S. E. Ky.	Louisville	1.75@ 2.50
Big Seam	Birmingham	2.00@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.25@ 3.50
Buckwheat No. 1	Philadelphia	2.40@ 3.00
Birdseye	New York	1.40@ 2.00

FUEL OIL

New York—Dec. 16, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis — Dec. 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6.151c. per gal.; 38@40 deg., 7.23c. per gal.

Pittsburgh—Dec. 7, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Dec. 8, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

Cincinnati—Dec. 14, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Dec. 1, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35 per bbl.; 26@30 deg., $1.45; 30@32 deg., $1.65.

Boston—Dec. 13, tank-car lots f.o.b. 12@14 deg. Baumé, 4.65c. per gal.; 28@32 deg., 5.9c. per gal.

Dallas—Nov. 11, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

Business Notes

The Liberty Electric Corp., of Stamford Conn., manufacturers of the Liberty valve operator and other engineering specialties, including radio equipment, announce the appointment of the Himelblau, Agazim & Co., 30 North Dearborn St., Chicago, Ill., as their Chicago representative.

The Parsons Marine Steam Turbine Co. announces that the new address of the company is 75 West St., Rooms 1504, 1505, Evening Post Bldg., N. Y. C.

The Bernitz Furnace Appliance Co. opened its own district office in the Illinois Merchants Bank Building, Chicago, Dec. 15.

The Electric Controller & Manufacturing Co., of Cleveland, Ohio, announces the removal of its Toronto office from the Traders Bank Bldg., to 415 Metropolitan Bldg., Toronto, Ontario.

The William Ganschow Co., Chicago, has appointed Harold D. Mitchell sales representative in the western half of New York state. Mr. Mitchell's headquarters will be located at 1543 Fillmore Avenue, Buffalo, New York.

Eadie, Freund & Campbell, consulting engineers, have removed their offices from 7 West 45th St., New York City, where they have been since October, 1914, to 110 West 40th St. In these quarters they will continue to specialize in the design of power plants, heating, ventilating, electric, plumbing, automatic sprinkler, refrigeration and elevator installations for all classes of buildings and industrial plants.

The Chain Belt Co., Milwaukee, Wis., announces that F. C. Wilcox, who for 18 years was president of the Foote Concrete Machinery Co., of Chicago, Ill., has joined the Chain Belt organization in the capacity of Eastern manager of Rex Paver sales, with headquarters in New York City.

The Illinois Stoker Co., Alton, Ill., manufacturer of Illinois forced and natural draft chain-grate stokers announces the recent consolidation of the K-B Pulverizer Corp. of New York, manufacturer of the Pulverburner. The Pulverburner is now being manufactured and sold by the Illinois Stoker Co. The New York office of the Illinois Stoker Co. for both stokers and pulverized-fuel equipment will be at 1948 Grand Central Terminal Bldg.

Trade Catalogs

Reducing Valves and Regulators—The Schutte & Koerting Co., Philadelphia, Pa., has issued a new bulletin 8-R, illustrating and describing diaphragm and relay-controlled pressure-reducing valves for steam lines. These valves are of several types, to cover the various operating conditions encountered in power and industrial plants.

Corrosion—The Quigley Furnace Specialties Co., New York City, has described its causes and methods of prevention in the booklet entitled "Protect your Plant and Equipment," This tells how Triple A Solutions differ from lead paints and explains their use in industrial plants to protect metal, concrete, wood and other surfaces that are exposed to moisture, especially where acid and alkaline conditions exist.

Water Testing Equipment—The Chicago Chemical Co., 6216 West 66th Place, Chicago, has just issued a booklet with pictures, descriptions and prices of kits for testing water in laboratories and power plants. The kits described range from the simplest to the most elaborate. Directions for use are given. Obtainable with this is a group of leaflets under the general title "Clean as a Whistle." These cover various phases of feed-water equipment.

New Plant Construction

Ariz., Phoenix—Syndicate, Walker & Eisen, Western Pacific Bldg., Archts., plans the construction of a bank, hotel and stores building at Central Ave., Monroe, First and Van Buren Sts. Estimated cost $2,000,000. Walker & Eisen, Western Pacific Bldg., Los Angeles, Calif., are architects.

Ark., Little Rock—William Young Hotel Co., Inc., c/o T. E. Burrow, Pres., 2407 Broadway, awarded contract for the construction of a 15 story hotel at Main and Markham Sts. to Stewart & McGehee Construction Co., Kahn Bldg. Estimated cost $800,000.

Calif., Flintridge (mail Glendale)—F. P. Flint, will build a hotel including swimming pool, etc. by day labor. Estimated cost $750,000. M. Hunt, 1107 Hibernian Bldg., Los Angeles, is architect.

Calif., Glendale—T. H. Westgate, et al., c/o W. E. Warne, 1111 Rives-Strong Bldg., awarded contract for the construction of an apartment including boiler room, etc. Estimated cost $150,000. One automatic electric elevator will be installed.

Calif., La Jolla—La Jolla-Del Mar Co., awarded contract for the construction of a 9 story hotel at Casa de Manana St. to H. H. Hinds, 351 South Hoover St., Los Angeles. Estimated cost $786,000. Steam heating system, 2 high speed elevators, etc. will be installed.

Calif., Lockeford—San Joaquin Waterworks Dist. No. 1 is having plans prepared for waterworks improvements including well, pump, mains, etc. Estimated cost $15,000. J. Henning, Lodi, is engineer.

Calif., Los Angeles—City will soon award contract for the construction of a sewage pumping plant on Mar Vista Ave. Estimated cost $24,286. E. W. Tuttle, City Hall, is engineer.

Calif., Los Angeles—Parkinson & Parkinson, Title Insurance Bldg., Archts., will soon receive bids for the construction of a 13 story office building including steam heating plant, elevators, etc. on Wilshire Blvd. and Westlake Ave. for Los Angeles County Medical Assn. Estimated cost $1,000,000.

Calif., Los Angeles—Merill & Rahn, Financial Center Bldg., Archts., are preparing preliminary plans for the construction of an 8 story hotel at 2nd St. and Grand Ave. Owner's name withheld.

Power Equipment Information Bureau

POWER offers you a complete market-information service dealing with the machinery, equipment and materials you need in the operation and upkeep of your plant. If you are looking for new machinery and equipment, your requirements will be listed free of charge in the McGraw - Hill Construction Daily.

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Calif., Los Angeles—H. J. Schmidt, c/o Frankfurt Co. Inc., 1096 North Western Ave., Contr., awarded contract for the construction of a 12 story apartment on Magnolia Ave. Estimated cost $750,000. Steam heating plant, 4 elevators, etc. will be installed.

Calif., Los Angeles—Southern California Athletic Country Club, awarded contract for the construction of a 13 story club building at Wilshire Blvd. and Coronado and Corondelet Sts. to Meyer & Holler, Wright & Callendar Bldg. Estimated cost $3,000,000.

Calif., Los Angeles—Water & Power Comm. awarded contract for condensers for steam power plant to Ingersoll-Rand Co, Higgins Bldg. Estimated cost $55,232.

Calif., Mare Island—Bureau of Yards & Docks, Navy Dept., Washington D. C., will soon receive bids for boiler feed pumps, motor driven centrifugal hot well pumps, etc. for boiler plant at Navy Yard hospital here.

Calif., San Francisco—L. B. Ham, 105 Montgomery St., is having plans prepared for the construction of a 20 story hotel at Ellis and Powell Sts. Estimated cost $1,500,000. E. M. Sharpe, 60 Sansome St., is architect.

Calif., San Francisco—E. A. Tropp, et al, c/o Hyman & Appleton, Foxcroft Bldg., Archts., is having plans prepared for the construction of a 15 story apartment at Pacific Ave. and Laguna Sts. Estimated cost $1,000,000.

Calif., San Francisco—U. S. Engineer Office, 85 Second St., will receive bids until Jan. 5 for furnishing an electric motor with controlling appliances for booster pump, also until Jan. 6 for a 20 in. booster pump.

Calif., Stockton—San Joaquin County Waterworks District No. 1, E. Graham, Clk., is receiving bids for waterworks improvements including well, pump and motor, tank on tower, etc.

Calif., Tracy—Banta-Carbona Irrigation Dist., W. Schlossman, Secy., will receive bids until Jan. 3 for furnishing and installing one centrifugal pump, 60 cu.ft. per sec., 35 ft. head, four centrifugal pumps, 60 cu ft. per sec., 25 ft. head, motors, etc. T. H. Means, 215 Pine St., San Francisco, is engineer.

Ill., Chicago—Sanitary District of Chicago, 910 South Michigan Ave., is having plans prepared for the construction of a pumping station at West Side Sewage Treatment Works. Estimated cost $1,500,000. Private plans.

Ill., Chicago—Syndicate, c/o C. W. Christensen, 134 North La Salle St., Archt., is having sketches made for the construction of a 9 story apartment at Jarvis Ave. and Sheridan Rd. Estimated cost $750,000.

Ill., Chicago—Syndicate, E. A. Grunsfeld, 431 North Michigan Ave., is having plans prepared for the construction of a 17 story apartment at 101-109 E. Delaware Pl. Estimated cost $4,500,000. E. A. Grunsfeld & E. Klaber, 431 North Michigan Ave., are architects.

Ill., Edison Park (mail Park Ridge)—United Scenic Studios, Inc., 28 West Lake St., Chicago, is having preliminary sketches made for the construction of an apartment and stores building at 6725 Northwest Highway. Estimated cost $750,000. F. Jacobs, c/o owner, is architect.

Ill., Washburn — City will receive bids until Jan. 10, for waterworks improvements including deep well, pump house, pumping equipment, etc. Kinsey Engineering Co., Arcade Bldg., Pekin, is engineer.

Ind., Indianapolis—N. Perry, 48 Monument Pl., is having preliminary plans prepared for the construction of a hotel on Pennsylvania and Ohio Sts. Estimated cost $3,000,000. Architect not selected.

Ind., Indianapolis—James Whitcomb Riley Hotel, had plans prepared for the construction of a 16 story hotel at Kentucky Ave. and Illinois St. Estimated cost $3,250,000. Rapp & Rapp, 190 North State St., Chicago, Ill., are architects. M. L. Hall, of Washington Bank & Trust Co. West Washington St. and Senate Ave., in charge of construction.

Ind., Whiting—Standard Oil Co., W. R. Burton, Pres., 910 South Michigan Ave., Chicago, Ill., is receiving bids for the construction of a steam power plant here. Estimated cost $1,000,000. R. E. Humphrey, Whiting, Ind., is engineer. Steam turbines and power plant equipment will be required.

Ia., Cedar Rapids—W. F. Naibert Realty Co., 220 Grandby Bldg., is having preliminary plans prepared for the construction of a 4 story theatre and office building at 3rd Ave. and 2nd St. Estimated cost $750,000. Peacock & Frank, 445 Milwaukee St., Milwaukee, Wis., are architects.

Ky., Louisville — U. S. Engineer Office, War Dept., Washington, D. C., awarded contract for the construction of a power house at dams 47 and 51 on the Ohio River, to C. Kanzler & Son Co. Inc., 500 Furn Bldg., Evansville, Ind. Estimated cost $35,585.

La., Jackson—D. Stewart, et al, Engrs., Natchez, Miss., will receive bids after Jan. 1 for the construction of a complete waterworks, distribution and electric lighting systems including 200 kw. unit here. Estimated cost $100,000.

La., Monroe — City plans an election Jan. 18, to vote $600,000 bonds for improvements to waterworks including dam, pumping equipment, mains, etc. W. T. Noel is engineer.

Md., Annapolis—Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Dec. 22, for the construction of a deferrization plant including motor driven centrifugal pump, etc. at Naval Academy (Marine Barracks) here.

Md., Williamsport—Potomac Edison Co., awarded contract for the design and construction of a steam power plant to Sanderson & Porter, 52 William St., New York, N. Y. Estimated cost $2,000,000.

Mass., Boston—P. O. Box 254, Station A, is in the market for a 10 to 15 hp., 110 v.d.c. gasoline engine and generator.

Mass., Cambridge (Boston P. O.)—Middlesex County Commissioners, A. Cutting, Chn., Court House, East Cambridge, awarded contract for the construction of a boiler house for County jail here, to W. J. Delaney, 283 Essex St., Lawrence. Estimated cost $175,000.

Mass., Cliftondale (mail Lynn)—C. A. Doane, 26 Eustis St., is in the market for one tubular boiler.

Mass., Somerset—Town, A. J. Eagen, Chn. of Committee, is having plans prepared for the construction of a waterworks system and pumping station. Estimated cost $500,000. F. A. Barbour, 1119 Tremont St., Boston, Mass., is engineer.

Mich., Detroit — Simon J. Murphy, Murphy Estate, Penobscot Bldg., is receiving bids for the construction of a 46 story office building including central steam heating system, high speed elevators, etc. at Fort & Griswold Sts. Donaldson & Meier, 1314 Penobscot Bldg., are architects.

Mich., Pontiac—The Griggs Co., 22 West Lawrence St., plans the construction of a group of apartment buildings including steam heating boilers and equipment on Douglas St. Estimated cost $625,000. Private plans.

Mo., Kansas City—City Ice Co., 21st and Campbell Sts., is receiving bids for the construction of an ice plant at 15th and College Sts. R. M. Oliver, 115 South Dearborn St., Chicago, Ill., is engineer.

Mo., Macon—City plans improvements to water and light plant. Burns & McDonald Engineering Co., 402 Interstate Bldg., Kansas City, are engineers.

Mo., Piedmont—Black River Hydro Electric Co., to be incorporated. W. H. Meredith, V. Pres. and Chief Council, had surveys made for the construction of a hydro-electric power dam, 135 ft. high and 1,500 ft. long to develop 10,000 kw. hp. on Black River near here. Approximately 22,000 acres of land for the lake to be formed by the dam. Total estimated cost $4,000,000.

Mo., St. Louis—Missouri Pacific R.R., Railway Exchange Bldg., will soon receive bids for the construction of a 22 story office building including vapor heating plant, vacuum system, 9 high speed elevators, etc. at 13th, Olive and Pine Sts. Estimated cost $2,000,000. R. M. Tucker, c/o owner is architect. E. A. Hadley, is chief engineer.

Mo., St. Louis — Syndicate, c/o B. Altheimer & Bro. Real Estate Co., Wainwright Bldg., is having preliminary plans prepared for the construction of a 10 story office building including 2 high speed elevators, etc. at 12th St. and Clark Ave.

N. Y., Brooklyn—Crow, Lewis & Weck, 200 5th Ave., New York, Archts., will receive bids until Dec. 22, for the construction of a hospital and home on Prospect Pl. here, for Jewish Hospital, Classon Ave., Brooklyn. Estimated cost $2,200,000.

N. Y., Middletown—State Hospital Comm., Capitol, Albany, will soon award contract for furnishing and installing a refrigeration plant in Middletown State Homeopathic Hospital, here.

N. Y., New York — Bellevue & Allied Hospitals, J. J. McGrath, Pres., 26th St. and 1st Ave., is having plans prepared for the construction of a 7 story hospital and dormitory. Estimated cost $750,000. McKim, Mead & White, 101 Park Ave., are architects.

N. Y., New York—Chase National Bank, A. H. Wiggin, Pres., 57 Broadway, plans the construction of a 30 story bank and office building at 14 Nassau St. Estimated cost $10,000,000. Architect not selected.

N. Y., New York—C. Galewski, c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 15 story apartment including 2 electric elevators at 441 Central Park West. Estimated cost $1,500,000.

N. Y., New York — Lexington Ave. and Sixty Third St. Corp., S. Pollard, Pres., c/o Murgatroyd & Ogden, 285 Madison Ave., Archts., is having plans prepared for the construction of a 23 story apartment including steam heating and ventilation systems, 3 elevators, etc. Estimated cost $2,500,000.

N. Y., New York — Maywell Operating Corp., c/o C. Kreymborg & Son, 2534 Marion Ave., Archt., is having plans prepared for the construction of a 6 story apartment including 2 electric elevators at Boscobel Pl. Estimated cost $500,000.

N. Y., New York—National Biscuit Co., R. E. Tomlinson, Pres., 85 9th Ave., had plans prepared for the construction of a bakery and office building including steam heating system at 505 West 14th St. Estimated cost $3,000,000. L. Wirschling Jr., 85 9th Ave., is architect.

N. Y., New York — One Hundred Fifty Riverside Drive Corp., c/o M. Deutsch, 35 Maiden Lane, Archt., is having plans prepared for the construction of a 15 story hotel including 4 electric elevators at Riverside Dr. and 87th St. Estimated cost $1,500,000.

N. Y., New York—Shampan & Shampan, 188 Montague St., Brooklyn, Archts., are preparing plans for the construction of a 20 story office building on West 29th St. here. Estimated cost $1,000,000. Owner's name withheld.

N. Y., New York — Six Hundred Thirty Nine West End Ave. Corp., c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 15 story apartment including 3 electric elevators, etc. at 91st St. and West End Ave. Estimated cost $500,000.

N. Y., New York—Twenty Nine Washington Sq. Corp., c/o Gronenberg & Leuchtag, 1385 Broadway, Archts., is having plans prepared for the construction of a 15 story apartment at Washington Sq. W. and Waverly Pl. Estimated cost $1,000,000.

N. Y., Syracuse—City plans the construction of a pumping station complete, at Hiawatha, Bear, Solar, Pulawsky, North Geddes, Kirkpatrick and Clinton Sts. Estimated cost $488,954. N. F. Pitts, Jr., City Hall, is engineer.

N. Y., Syracuse—Syracuse Memorial Hospital, Bd. of Trustees, 201 Green St., will soon receive bids for the construction of a hospital and nurses' home on Crouse Ave. Estimated cost $2,500,000. J. R. Pope, 542 5th Ave., New York, is architect.

N. C., Raleigh—City plans the installation of a complete refrigeration system at city market.

O., Canton—City plans improvements to waterworks including wells, pumping equipment, etc. Estimated cost $100,000. W. E. Sarver, City Hall, is engineer.

O., Columbus—Allied Associated Architects, R. C. Kempton, Managing Archt., 82 West Broad St., is making sketches for the construction of group of municipal buildings including central heating plant, etc. at Water and Broad Sts. Estimated cost $800,000.

Okla., Okmulgee—Chamber of Commerce, is having preliminary plans prepared for the construction of an 8 story hotel on Third St. Estimated cost $800,000. Architect not selected.

Okla., Weleetka—Public Service Co., 51 South Boston St., Tulsa, awarded contract for the superstructure of power plant, 15,000 kw. capacity here, to Myers Construction Co., c/o Legion Hotel. Estimated cost $1,000,000.

Okla., Talogo—City plans an election Dec. 20, to vote $30,000 bonds for the construction of a new electric light plant including electric distribution system, two 100 hp. Diesel oil engines, generators, etc. Sherman Machine & Iron Works, 18-32 East Main St., Oklahoma City, is engineer.

Pa., Philadelphia—J. Rabinowitz, 37th and Walnut St., awarded contract for the construction of a 13 story apartment at 23rd and Walnut Sts. to Boyle Robertson Construction Co., Evans Bldg., Washington, D. C. Estimated cost $750,000.

Tenn., Memphis—U. S. Engineer Office, War Dept., Washington, D. C., will receive bids until Dec. 30, for two 500 hp. unaflow engines, here.

Tex., Galveston—Jean Lafitte Hotel Co., S. Moody, American National Insurance Bldg., will receive bids about Jan. 1, for the construction of a 10 story hotel including 4 elevators, etc. Estimated cost $500,000. Andrew Fraser, c/o American National Insurance Bldg., is architect.

Tex., Houston—Houston Building Exchange Co., c/o C. A. Thanneiser, Pres., 428 West Bldg., had preliminary sketches made for the construction of a 10 story office building. Estimated cost $500,000. J. Finger, 714 Keystone Bldg., is architect.

Tex., San Angelo—Marland Oil Co., will receive bids after Jan. 1 for the construction of a steam pumping station in Section 6, Block 35. Estimated cost $100,000. Private plans.

Wis., La Crosse—N. Nustad & Co., 124 South Front St., plans the construction of a wholesale warehouse on Main St. Estimated cost $50,000. Architect not selected. Refrigeration machinery will be required.

Wis., Park Falls—Flambeau Paper Co., E. P. Sherry, 461 Jefferson St., Milwaukee, Pres., plans the construction of a hydro-electric development including power plant and dam on the Flambeau River near here. Mead & Stone, State St., Madison, are engineers.

Ont., Ottawa—Dept. of Public Works, S. E. O'Brien, Secy., will receive bids until Dec. 28 for equipment for cold storage plant and incubator room, also the installation of a refrigeration plant and research station at Hull, Que.

Ont., Ottawa—Ottawa Electric Co., 35 Sparks St., awarded contract for the construction of a 9 story office building to A. J. Garvock, Regent Bldg. Estimated cost $600,000 to $800,000.

Que., Montreal—Star Publishing Co., Ltd., St. James St., is having plans prepared for the construction of a 15 story office building. Estimated cost $800,000. W. H. Wardwell, 628 Union Ave., is architect.

N. Z., Wellington—New Zealand Government Railways, will receeive bids until Feb. 14 for electrical equipment, switchgear, armoured cables, junction boxes, trifucating boxes, motor generator sets, etc. for new car and wagon shops at Attdlurton.